HISTORY OF CHEMISTRY

IN

ANCIENT AND MEDIEVAL INDIA

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INCORPORATING THE

History of Hindu Chemistry

BY

ACHARYA PRAFULLA CHANDRA RÂY

Edited by

P. RÂY

Professor (Hon.) of Chemistry, Indian Association for the Cultivation of Science. Formerly, Palit Professor and Head of the Department of Pure Chemistry, University College of Science, Calcutta

INDIAN CHEMICAL SOCIETY

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FOREWORD

As the History of Hindu Chemistry by the late Acharya Prafulla Chandra Rây, the Founder-President of the Indian Chemical Society, went out of print some two decades ago, and the necessity for its republication was being felt by all students of the history of science, the Council of the Society at one of its meetings in 1948 decided to publish a revised edition of the book. It was further resolved that the new publication should incorporate all additional important materials that had since been brought to light, and that its name should consequently be changed to "History of Chemistry in Ancient and Medieval India". A publication board comprising a few distinguished Fellows of the Society with Prof. Priyadaranjan Rây as the Editor, was constituted for the purpose, and Prof. Rây was entrusted with the task of preparing the manuscript.

As the resources of the Society were too limited to meet the cost of the publication, an appeal for financial assistance to the scheme was issued. In response to this the Society received a sum of Rs 13,153/- as donations from various organisations. The fund has recently been augmented by a grant of Rs. 5,000/- from the Government of India. The names of the Donors with their respective contributions are given below :

1.	Government of West Bengal	.. Rs. 5,000/-
2.	Government of India	. Rs. 5,000/-
3.	Bengal Chemical & Pharmaceutical Works Ltd., Calcutta	. Rs. 5,000/-
4.	UNESCO	.. Rs. 1,653/-
5.	The Calcutta Chemical Co., Ltd., Calcutta	... Rs. 1,000/-
6.	Alembic Chemical Works Co., Ltd., Baroda	... Rs. 500/-
		Rs. 18,153/-

The Society takes this opportunity of recording its grateful appreciation of the generous help received.

It was originally announced that the book would be placed before the public by the end of 1953 or in the early part of 1954, but owing to certain unforeseen circumstances over which the Society had no control, the publication has been considerably delayed. For this, the Society owes an apology to all its Donors, Fellows and Subscribers. The Society also regrets that, due to some difficulties connected with the press, some printing errors have crept into the text.

It is indeed a matter of great misfortune for the Society that one of the members of the publication board, Dr. S. S. Bhatnagar, did not live to see the publication of the book.

In spite of all its imperfections, it is hoped that the present volume will be found as useful as its original edition, the "History of Hindu Chemistry" The Society has placed itself under a deep debt of gratitude to Prof. Priyadaranjan Rây for his painstaking and devoted work in connection with the revision and editing of this great book by the late Acharya.

S. K. Mukherjee
Secretary.

B. C. Guha
President.

INDIAN CHEMICAL SOCIETY
Calcutta, *January* 1, 1956.

PREFACE

History does not, as generally represented, consist merely in the shifting of geographical boundaries of countries and dominions, in the changes of their names, in the military exploits of royalties and nations, or even in the undulations and migrations of greater and lesser waves of populations. These are but the casual and external changes, and may be viewed upon as the symptoms of the great mental vicissitudes of the human race. In the opinion of many eminent thinkers, individual fortunes or individual events, by themselves, are not of real importance in history, though they may be highly sensational or of great political and economic significance for the time being and occupy the headlines of newspapers. History, from a philosophical point of view, represents, in fact, a long range process involving very long durations and very large numbers. Individual persons or events are important in history to the extent they serve as symptoms of this long range process and as means to the realization of this process. For, individuals have their rise and decay, while history is a continuous process and knows no end. The real history of mankind is, therefore, constituted by the thoughts of the past; the leading conceptions of all remarkable forms of civilization; the achievements of genius, of virtue and of high faith. In short, it is the record of the past experience of humanity and of the evolution of the human mind with its ideas and sentiments, its truths and toils, its virtues and guilt. The scientific and cultural achievements of mankind, representing the progress of civilization, therefore, supply the materials for real history. In fact, history becomes utterly incomplete, if it fails to narrate the progress and development of science which has led to the modern civilization with its remarkable achievements. If there be any unfailing criterion for the growth of civilization or the evolution of human mind, it lies in the progressive unification of the world to which science has undeniably made the greatest

contribution, inspite of the two frightful international conflicts on a global scale and a more intensive preparation for the third, aided by catastrophic atomic weapons derived from the pursuit of science itself. History of science, therefore, constitutes an integral part of the history of human civilization or of the true human annals of the earth; and as knowledge and wisdom grow only on the accumulated experiences of the past, it forms an essential element in the study of science itself.

But, to write a history of science, or any special part thereof, is no easy task. For, in the first place the writer must know both science and history; even the most perfect understanding of the one is inadequate for the purpose without some information of the other. Then again. he must assume a psychological detachment as a safeguard against all prejudices that tend consciously or unconsciously to exalt national or racial pride and thus influence his judgment. The task of the present writer is, however, considerably lightened not only by the limitation of his scope to the history of chemistry in ancient and medieval India, but also by the fact that he had merely to edit and more or less revise the pioneering work, the History of Hindu Chemistry, by his illustrious teacher Acharya Prafulla Chandra Rây. But at the same time, it must be admitted that the chronology, relating to the compilation of many ancient Indian treatises—literary, scientific or religious, is in a state of almost hopeless confusion. There is seldom any unanimity among the experts on any particular topic in this connection. The usage of ancient authors in recording the time of their composition by the period of the reign of the monarchs, under whose protection and patronage they lived and wrote, has contributed in no small measure to this confusion. Besides, there was no universally accepted era with definite origin, on the basis of which the dates could be calculated. As a result, there has been much controversy about the original source of many ideas and of the knowledge of many facts, the priority whereof might be claimed both by the Hindus and the Greeks of the early ages. It should not, however, be forgotten that one and the same idea might be

conceived, or the knowledge of one and the same fact might be acquired, almost simultaneously or at slightly different periods of time by people in different countries in a perfectly independent manner. For, the evolution of human intellect is known to follow more or less the same pattern everywhere, irrespective of any geographical limitations. In the absence of any definite record of indisputable evidences, such controversies about any particular nation borrowing concepts and knowledge from the other, are obviously of little historical significance. They are likely to arouse, on the other hand, mere national vanities. In the present volume, the editor has, therefore, tried to adhere to the least controversial dates after a careful consideration of the balance of reliable evidences. Moderation, rather than extremism, has been a watchword with him, but without any irrational reverence for it. How far he has succeeded in his efforts is left to the judgment of competent authorities on the subject.

The History of Hindu Chemistry by P. C. Rây went out of print nearly a quarter of a century ago. It had been the only publication which gave a systematic account of the achievements of the early Indians in the field of chemical knowledge. As a result, the students and historians of chemistry have keenly felt the need of filling up the void created thereby. In order to meet this demand the Council of the Indian Chemical Society decided some years ago to publish a revised edition of the History of Hindu Chemistry of the late Acharya P. C. Rây, who was the Founder President of the Society. The task of editing was entrusted to the present writer. In this new volume under the name of 'History of Chemistry in Ancient and Medieval India' much new materials have been added, and all facts have been carefully sifted with a view to exclude those of doubtful origin or spurious character Reference has also been made to the social and cultural conditions of the country, associated with the different stages of development of chemical knowledge. Evidences, supported by illustrations wherever possible, of the skill displayed by the early Indians in the art of making glazed pottery, in the extraction and working of metals,

in the preparation of caustic alkalies, oxides and sulphides of metals, etc., have been recorded It is expected that the *students and historians of science will find in the book sufficient* materials of interest and value for the proper assessment of the ancient Indian civilization and culture.

As in the History of Hindu Chemistry, a discussion on the decline of scientific spirit in India has been introduced in a separate chapter. The section on the mechanical, physical and chemical theories of the ancient Hindus by B N. Seal has also been included as an appendix, though somewhat abridged from what appeared in the *History of Hindu Chemistry*. The original Sanskrit Texts in Devnagri script, relating to the main topics of the book, are reproduced after the appendix without any change from the History of Hindu Chemistry. This is followed by the reproduction of the Tibetan Texts in Roman script. The English translation of the Tibetan Text, Rasāyanasāstroddrti, which could not have been included *in the main book, is also added here. The editor is deeply* indebted to Sri Suniti Kumar Pathak, M.A., of Visvabharati University, Santi-Niketan, Bengal, who very kindly transcribed and translated this text from the Tibetan xylographs for the present volume.

It is indeed a great pleasure for the editor to express here his deep sense of gratitude to Professor P. K. Gode, M.A., of Bhandarkar Oriental Research Institute at Poona, who was very kind enough to go through the entire manuscript of the book and to help the editor with many valuable suggestions and useful informations The editor also desires to record his appreciation of the great service and assistance he has received from Sri Debabrata Bose, M.A. of City College, Calcutta, in collecting new materials for the book. He further wishes to express his indebtedness to some publishers and friends for permission to use their illustrations and photographs These are acknowledged at the appropriate places

Calcutta, *January* 1, 1956 EDITOR



ACHARYA PRAFULLA CHANDRA RAY

Born August 2, 1861 *Died. June 16, 1941*

ABOUT THE AUTHOR OF THE

History of Hindu Chemistry

ACHARYA PRAFULLA CHANDRA RÂY

Born in a cultured and rich family in the district of Khulna, now in East Pakistan, in 1861 (August 2) Prafulla Chandra imbibed from his very childhood through the influence of his father, who was a landed proprietor with liberal education, the principles of rational thinking and the value of disciplinary methods. After his preliminary education in his father's village school up to the age of nine, when the family migrated to Calcutta, he joined the Hare School and subsequently the Albert School. From the last named institution he passed the Entrance Examination in 1879. A persistent attack of dysentery in his school days left a permanent stamp of weakness upon his constitution. For his further study he joined the Metropolitan Institution, now known as Vidyasagar College, and used to attend the lectures on Physics and Chemistry at the Presidency College, Calcutta. The lectures and experiments of Professor Pedler in Chemistry at the latter institution stirred his imagination and awakened in him a spirit of enquiry and interest in natural science In 1882 he obtained the Gilchrist Scholarship, which enabled him to proceed to the United Kingdom and join the University of Edinburgh in the Faculty of Science. There he came under the influence of Professor Crumbrown in Chemistry which became his favourite subject. Alexander Smith and James Walker were his class-fellows. He obtained his D.Sc Degree in 1888 and became the recipient of several scholarships in the Edinburgh University.

On his return to India, Rây was apponted Assistant Professor of Chemistry at the Presidency College, Calcutta, in 1889, where in 1911, only a few years before his retirement, he

became the Senior Professor. Here he established a very high reputation as a successful teacher and investigator, and gathered around him a band of devoted research workers. He and his colleague Jagadis Chandra Bose, the then Professor of Physics at the Presidency College, were the first Indian teachers to initiate research work in natural science and to inspire young minds with a spirit of enquiry, desire for knowledge and quest for truth He used to take special delight in the study and teaching of the history of chemistry. In 1902 he published the first volume of his momumental work, the History of Hindu Chemistry, the second volume of which appeared in 1908. This was the result of a long and painstaking research, extending over a period of 15 years, and gives us a glimpse into the achievements of the early Hindus in the domain of positive science. The book was rightly acclaimed as a valuable contribution to the history of science

In 1916 he retired from the Presidency College and assumed charge as the Head of the Department and Palit Professor of Chemistry in the newly started University College of Science, Calcutta Both at the Presidency College and at the University College of Science, Rây succeeded in training and inspiring successive bands of devoted research workers who dedicated themselves to scientific career. Gradually an Indian School of Chemistry came into being, largely through his example and influence. The publications from his laboratories at the Presidency College and the University College dealt with a large variety of chemical problems and numbered about a couple of hundred He took a leading part in the inauguration of the Indian Chemical Society in 1924, of which he was the Founder President for the first two terms The Society received liberal finacial aids from him from time to time

Ray retired from his position as Palit Professor of Chemistry of the University College of Science in 1936 at the age of seventy-five, and remained as an Emeritus Professor till the end of his life He made a free gift of his salary during the last 15

years of his service to the University for the extension and development of the Department of Chemistry in the University College of Science and Technology. Several Research Fellowships and Research Prizes are being maintained out of the interests of the fund thus endowed.

Prafulla Chandra received many honours in life. He was the recipient of Honarary Degrees of D.Sc. of the Universities of Durham, Dacca, Calcutta and Banaras. In 1911 he was made a Companion of the Order of the Indian Empire and was knighted after the first world war. He was elected General President of the Indian Science Congress in 1920, and in 1934 became an Honorary Fellow of the Chemical Society, London, and also of the Deutsche Akademie, Munchen a little earlier.

Rây was also held in great respect as a pioneer of chemical industries in india. In or about 1900 he founded the Bengal Chemical and Pharmaceutical Works, which was converted into a limited concern in 1902. He was also associated with a large number of industrial organizations.

As a social worker and social reformer Rây rendered singular services to his country. He was ever ready to come to the rescue of suffering humanity, stricken by famine, flood or other natural calamities.

Though a scientist by profession, his love for, and knowledge of, literature and history were rather remarkable. Tagore, Michael and Shakespeare were his favourite poets, from whose works he could quote off-hand from memory. The writings of Emerson and Carlyle fascinated him greatly. A measure of his interest in literature and history can be obtained from his oft-repeated remarks that 'he became a chemist by mere accident'. The first volume of his autobiography, Life and Experiences of a Bengali Chemist, was published in 1932, which was followed by a second volume in 1935. The book was dedicated to the youths of India with the hope of stimulating their activities for national regeneration. It provides an

instance of his high literary ability. Professor Armstrong, while reviewing it in *Nature*, made the following comment

'From beginning to the end the message of the book is one of the highest endeavour—pulsating with vitality and intellectual force".

Prafulla Chandra had a poor health, *being* victim of chronic dyspepsia and occasional insomnia. He lived a single and a very simple life of austerity, and always placed principles and ideals above material interests. It was a life of self-denial, but invigorated by the perennial fountain of all pure humanities. He gave away in charity almost all that he earned, keeping only the irreducible minimum for himself. It may be said of him that his wealth lay in the smallness of his wants.

In politics, though never an active participant, Prafulla Chandra belonged to the nationalist school. The emancipation of India—political, social and economic, was his life's dream, for which he never ceased to strive. But unfortunately, he did not live to see the realization of his dream, as he passed away after a short span of illness on June 16, 1944, only a few years before India gained her independence. No truer picture of his life can possibly be depicted in words than that presented by the following quotation from what Sir Edward Thorpe wrote in *Nature* as early as 1919 .

"Her (India's) elevation will not come in Sir Prafulla Chandra Rây's time. A small spare man, in feeble health, and a confirmed dyspeptic, he will be spent in her service But the memory of these services will survive".

CONTENTS

INTRODUCTION

Chemistry in ancient India, as in all other countries, had its origin in the development of practical arts to meet the demand for the necessities of life, as also in the speculation about the nature and composition of matter. The two great human instincts, self-preservation and an urge for knowledge, are thus responsible for its birth and growth, as for many other human achievements.

The earliest evidence of chemical knowledge possessed by the ancient Indians in the prehistoric age has been brought to light by the findings of archæological excavations in Baluchistan, Sind and the Punjab. These reveal the existence of a pre-Aryan civilization, particularly at Mohenjo-daro in Sind and at Harappa in the Punjab, closely linked with, and akin to, the Sumerian Culture of Mesopotamia and the Nile-Valley civilization of Egypt. According to the opinions of experts and competent authorities the Harappan Culture flourished during 2500—1800 B.C. round about the flood plains of the river Indus and its five tributaries. Hence, it is frequently referred to as the Indus Valley Civilization of the early Bronze Age. The ruins of this ancient civilization that have been unearthed at Mohenjo-daro and Harappa furnish much information about the chemical knowledge acquired by the Indus Valley people, particularly with reference to the practical arts like pottery, brick-making and the extraction and working of metals. Excavations at different localities in Baluchistan and at some parts of Sind provide evidences for still more ancient settlements with their characteristic cultures dating as far back as the fourth millenium B.C. The findings testify to the facts that the people in the remote ages were acquainted with the art of making painted potteries, as well as with the preparation and working of metallic copper.

After the decline of the Harappan Civilization there followed a dark age in India, or almost an extinction of civilization, so to say, till after the advent of the Aryans near

about 1500 B C. The Aryans, to begin with, were pastoral people, but they gradually built up a civilization characterized by a remarkable progress in the pursuit of science, literature, arts, philosophy and religion. Since the beginning of this civilization the evolution of chemistry may be said to have proceeded in a more or less uninterrupted course inspite of numerous political and social changes in the country till it suffered a gradual but mysterious decline towards the end of the middle ages, just at a time when science was emerging with an extraordinary vitality on the continent of Europe. In his history of Hindu Chemistry P. C. Ray has shown that there are four successive stages in which chemistry may be said to have developed in ancient and mediæval India since the Vedic Age. These are distinguished as the Ayurvedic Period, the Transitional Period, the Tantric Period and the Iatro-chemical Period. They are not, however, mutually exclusive, but merge into one another

Considering the pursuit of chemistry by the prehistoric Indians before the Aryan conquest to constitute a separate period of its own, we propose to divide the present volume into five sections in chronological order.

A short account of the cultural background in each period has been given which will facilitate a proper understanding of the development of chemical knowledge of the time.

The Prehistoric Period may be said to have extended from about 4000 B C. to 1500 B C ; the Ayurvedic Period from the Vedic Age or pre-Buddhistic era to circa 800 A.D., the Transitional Period from 800 A D. to circa 1100 A.D.; the Tantric Period from 800 A.D. to circa 1300 A.D. ; and the Iatro-chemical Period from 1300 A D to circa 1550 A.D. To these we have added another section giving an account of the chemistry in practical arts, as pursued in India, till the break-up of the Mogul Empire or her annexation by the British (circa 1800 A.D.).

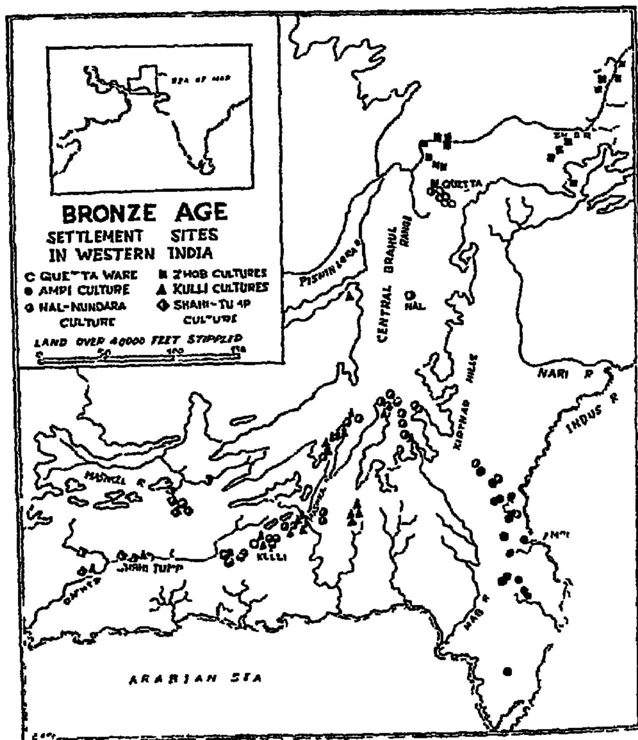


Fig. 1. (Piggot, *Prehistoric India*, 1950)

PREHISTORIC INDIA

(Circa 4000 B C—1500 B C)

CHAPTER I

PRE-HARAPPAN PERIOD

(Circa 4000 B C—2000 B C)

Evidences of the earliest cultural settlement in India have been obtained from the excavations in Baluchistan and the neighbouring parts of Sind Earliest agricultural communities yet known in India have been indentified in these mountainous and desert areas of the country. It is estimated to date back in the fourth millenium B. C. and shows a close relationship with the ancient Bronze Age Culture of the neighbouring regions of Western Asia. Various settlements that have been unearthed are believed by the archæologists, to represent more or less independent cultures of their own, and a classification has been made on the basis of the techniques employed in pottery painting. People in these ancient settlements were all acquainted with the art of making potteries of burnt clay and painting them with various designs. A broad classification, based on the colour of the wares, has been made with subdivisions named after the sites of occurrence as shown below (*cf.* Fig. 1).

I. Buff-ware Cultures:
   - (a) The Quetta Culture.
   - (b) The Amri-Nal Culture (with Amri in Sind and the Nal Valley in Baluchistan).
   - (c) The Kulli Culture (in South Baluchistan).

II. Red-ware Cultures:
   - (f) The Zhob Cultures (from sites in North Baluchistan).

The pottery from the Quetta sites has got a buff-body, painted over with designs in a purplish brown or black paint.

The wares from Amri and from the Nal Valley are more or less of the same type, which justifies their treatment under one head (*cf.* Fig 2*a* and 2*b*).

The houses in these settlements were made of stone and mud bricks with a refinement of white plaster in some instances over the inner faces of the walls In a cemetery at Nal a flat copper axe was found besides many pottery vessels and beads in certain areas, and two hoards of copper implements were observed at another place.

The colour of the Amri-Nal pottery body is a very fine soft buff or pink On this a white slip is frequently applied as a background for painted designs Polychrome pottery vessels have also been found at Nal with red, blue, green and yellow paint.

Copper axes and chisels, found in the Nal cemetery, have not been all analysed : but a fragment of an axe found near about the cemetery gave on analysis

Copper	.	93.05 per cent.
Lead	.	2.14 „ „
Nickel	...	4 80 „ „
Arsenic		trace (*cf.* Piggott, *Prehistoric India*, p.90)

The high percentage of nickel is rather significant and reminds one of the copper objects from Mesopotamia of Early Dynastic specimens as also of copper articles found at Mohenjo-daro and at Harappa as we shall discuss hereafter. The presence of nickel has been attested in the copper ores of Rajputana and Afghanistan But it is quite likely that the metal was derived from a local Baluchi ore, as ancient copper workings are alleged to exist in Baluchistan The lack of communication and the independent character of these early agricultural settlements of small size exclude the possibility of its being obtained from a distant source The comparatively very low percentage of arsenic in the metal also indicates a source different from that of the Harappan copper.



Fig. 2a. Polychrome Nal wares (Piggott, *Prehistoric India*).

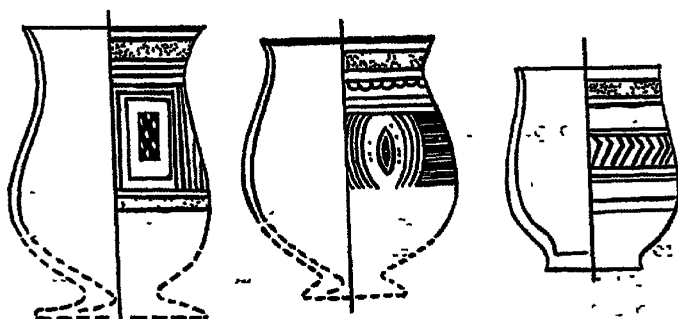


Fig. 2b Amri wares (*Ancient India*, 1946).

Among the other findings in the Nal cemetery, beads made of agate, carnelian and lapis lazuli may particularly be mentioned. Lapis lazuli was probably obtained at a later date from contact with the Harappan folk who acquired this substance mostly from Persia and Afghanistan Beads made of a glass frit, very similar to faience, found in the cemetery must also be of later date, indicating contact with the Harappan people. The finding of a perforated stone weight very similar in shape to those from Mohenjo-daro confirms this view.

A third series of sites of settlements in South Baluchistan in the Kolwa region gives evidence of a distinctive culture, named as the Kulli Culture, characterised by their painted pottery style. Pottery, baked clay figurines and copper objects have been found in the cemeteries in the Kulli region. Influence of the Harappa style in the potteries of later periods can be detected. The painting on the pottery body is generally of a black colour with an occasional use of red. There is frequently a pale red or sometimes a whitish slip, on which the painted design is placed. Clay figurines representing cattle, particularly the humped bull, are painted The figurines of women, however, are of a single colour, though their modelling is more elaborate and ornamental Vessels carved out of soft stone also form a special feature of Kulli Culture, indicating contact with the Indus Valley Civilization. Copper and bronze objects form a surprisingly large part of the grave-goods deposited with the cremations Cremation cemeteries have been unearthed at some sites in the Kulli region, particularly at Mehi A copper mirror, 5 inches in diameter with a copper handle representing a stylised female figure, constitutes a most outstanding find in the Mehi cemetery It reflects indeed a great credit to the inventive skill of these early Baluchistan metal-workers The same cemetery was found to contain another copper mirror in the shape of a circular disc, 5 inches across and without a handle, besides two copper pins, one with a flat, disc-shaped head and the other with a head of small lapis lazuli bead Fragments of simple copper bracelets and of small bowl (containing, as

found on analysis, traces of nickel) were the other articles to be noted. A copper pin with a somewhat bent head was found also at Kulli, as well as a fragment of sheet gold. Beads of lapis lazuli and agate also occurred in numbers (*cf.* Fig. 3).

There is good evidence of trade exchanges and movement of people between these Baluchistan settlements and those of the Indus Valley. Points of contact between the Kulli Culture and that of Mesopotamia also become evident from a consideration of the similarity in composition and spirit, and to some extent in technique, between the two groups of pottery. According to Piggott there is some evidence that the merchants of Baluchistan went by sea to settle in Sumer (Mesopotamia) much earlier than the trade between the Indus Valley or Harappa people and those of the twin rivers in Mesopotamia was established.

Sites of allied prehistoric settlements have also been discovered in North Baluchistan, particularly in the valley of the Zhob river. These are not so numerous as those of Sind or South Baluchistan. They represent, however, a group of cultures which though akin to those already described, yet possess some distinguishing characteristics of their own. They are connected possibly with the Red-ware Cultures of Persia. These Zhob Cultures show more or less a distinctive painted pottery style with a red pottery body. Towards the later stages of the Zhob Cultures contact with the Indus Valley Civilization becomes evident, as in the case with the South Baluchistan Cultures. The painting is stylish with red and black on the red body of the wares, recalling the Amri technique and suggesting an interchange of ideas. A series of important prehistoric towns on the spot in the final stage of their development with settlements or trading posts established by the Harappan people are implied by a consideration of the change in the pottery technique found in the articles from different stratified deposits. As in the Kulli Culture of South Baluchistan a number of clay figurines of cattle and women have also been found in the Zhob Valley settlements. In the earlier

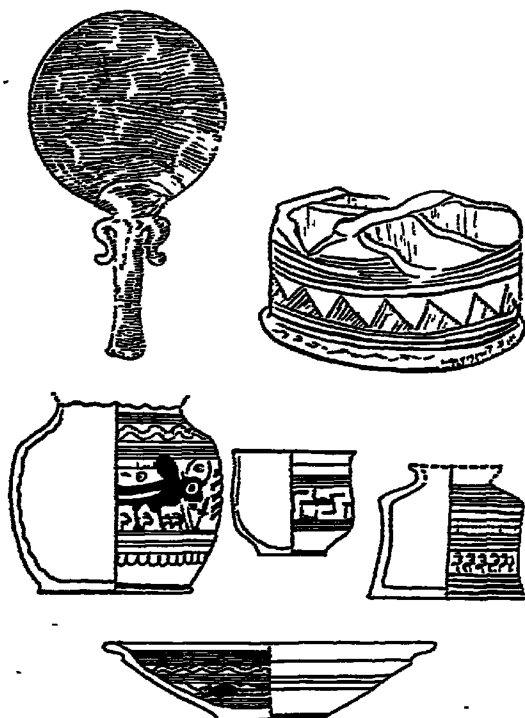


Fig. 3. Typical Kulli wares (*Ancient India*, 1946).

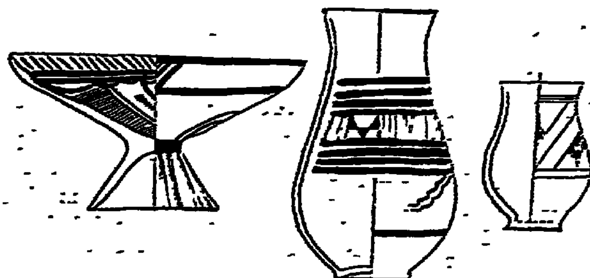


Fig. 4. Typical Zhob wares (*Ancient India*, 1946).

deposits there is little evidence of metallic articles, but copper objects, and beads of lapis and jade have been obtained from the latest strata indicative of possible Harappan occupation on the site (*cf.* Fig. 4).

In conclusion, it may be stated that the early Baluchistan settlements must have a priority over the Indus Valley Culture and should be dated well back in the fourth millenium B.C., while the later settlements began in the Early Dynastic Period of Sumerian Culture near about 2800 B.C. and continued to overlap with the Harappan Culture or even later.

We have seen that these prehistoric people were acquainted with the art of making baked or burnt clay pottery, as well as painting the same with two or more colours. This implies the construction of open and closed kilns. They also knew the art of extracting copper from the copper ores and of working the metal into various articles by hammering, cutting and rolling. Closed pottery kilns with their reducing atmosphere served satisfactorily for the smelting of copper ores for which the temperature needed does not exceed 700°-800°C. But no evidence of cast copper articles has been obtained, showing that, as a much higher temperature of about 1100°C for melting copper for the purpose is necessary, the construction of an advanced type of furnace to produce this high temparature was not evolved at the time. Nevertheless, with the development of the art of painted and polychrome pottery, and that of smelting copper from copper ores, it may be said that these prehistoric people of the fourth and third millenium B.C. laid the foundation of chemistry and of metallurgy in India.

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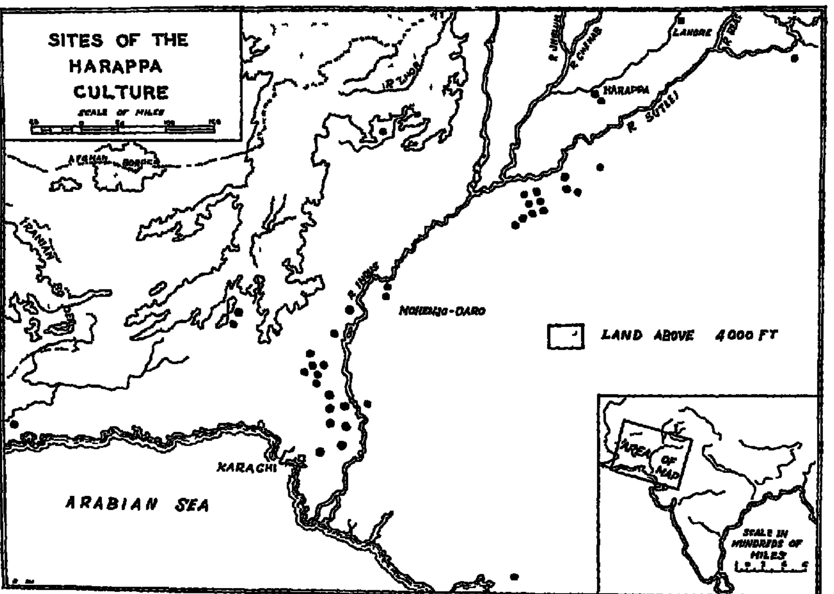


Fig. 5. (Piggot, *Prehistoric India*, 1950).

CHAPTER II

INDUS VALLEY CIVILIZATION

(2500 B. C.—1800 B. C.)

A prehistoric settlement of a different type from those of the more or less self-contained little peasant communities of Baluchistan and the neighbouring regions of Sind developed itself since 2500 B. C. on the flood plains of the Indus (Sind) and its five tributaries (the Punjab). This was symbolized by populous cities, highly skilled industries, extensive commerce with river communications; a pictographic script and definite standards of weights and measures, as revealed by excavations at Mohenjo-daro in Sind and Harappa in the Punjab. It embraced a vast territory extending from the Makran coast to Kathiawar, bounded on the west by the mountains of Baluchistan and Waziristan, on the north by the Himalayan Hills and on the east by the Thar desert (*cf.* Fig. 5). The recent exploration in the valleys of the rivers Saraswati and Drishadwati in Bikanir by A. Ghosh of the Archæological Department of India shows that Harappan Civilization extended further east beyond the Thar desert into Rajputana. The pottery specimens, as well as the copper and bronze objects, found here resemble closely those of the Harappan Culture. This is also supported by the excavations of painted grey wares in an ideal setting and sequence at Hastinapur near Meerut in 1951-52. It represented a civilization as uniform as that of Sumer in Mesopotamia and of the Nile Valley in Egypt. Some forty different settlement sites with two great citadel cities at Harappa and Mohenjo-daro have already been disinterred. Findings of the excavations demonstrate a surprising uniformity in the construction and technique of its pottery vessels produced on a mass scale, in its houses built of baked bricks of standard dimensions, and in the stamp seals with an yet undeciphered uniform script. Some of the settlement sites are villages and the others appear to be small towns with the two large citadel cities of Harappa

and Mohenjo-daro as twin capitals. The entire settlement area can be viewed, in the opinion of some archaeologists, as representing a vast kingdom or empire of the early Bronze Age in India (Fig. 5). The civilization that was evolved here is known as the Indus Valley Civilization or Harappan Culture. It is believed to be allied to the Sumerian and Egyptian Cultures, and there are evidences of contact and trade exchanges between the people of the Indus Valley and those of Sumer and Egypt. Archæological finds in and around the two citadel cities show an absolute uniformity in their articles, well-planned streets, magnificent systems of drains regularly cleared out, commodious two storied houses of baked bricks, granaries of large size, public baths, pillared halls, etc. They suggest, as Piggott concludes, a highly efficient centralized government by a divine monarch or a small priestly caste, and a regular local municipal administration. Monotonous rows of miserable mud-brick tenements outside the city walls suggest quarters for labourers or artisans. According to the opinion of some competent authorities, Harappa and Mohenjo-daro are the twin capitals of one and the same kingdom linked by a continuous river thoroughfare and controlled by a common authority having a dual seat of government.

The sites of both the cities are laid out on a common ground plan with a rectangular impressive citadel on an artificial platform about 30 ft. high with strong defensive walls. The citadel contains public and ceremonial buildings and processional terraces. Below the citadel are the streets and houses of the town and the industrial quarters for the labourers (Fig. 6).

The essential characters of the cities and their rulers are thus described by Wheeler in *Ancient India*, No 3, 1947:

"Whatever the source of their authority—and a dominant religious element may fairly be assumed—the lords of Harappa administered their city in a fashion not remote from that of the priest-kings or governors of Sumer and Akkad In Sumer, the wealth and discipline of city-state were vested in their chief

SITE PLAN OF MOHENJO-DARO

GREAT BATH

CITADEL

TO HARAPPA 400 MILES

BLACK AREAS DEFENCES
HATCHED AREAS EXCAVATED

SCALE OF FEET

SITE PLAN OF HARAPPA

RIVER BED

HARAPPA VILLAGE

GRANARIES

WORKING FLOORS

WORKMEN'S QUARTERS

CITADEL

CEMETERY H

CEMETERY R37

TO MOHENJO DARO 400 MILES

TO MONTGOMERY 15 MILES

Fig. 6. (Piggot, *Prehistoric India*, 1950)

deity, i. e. in the priest-hood or a priest-king. The civic focus was the exalted temple, centre of an elaborate and carefully ordered secular administration under divine sanction. In essence, the picture is one of a rigid and highly evolved bureaucratic machine, capable of organizing and distributing surplus wealth and defending it, but little conducive to the political liberty of the individual."

The archæological evidences, according to Wheeler, Piggott and others, therefore, suggest that the Indus Valley Civilization was evolved in a state ruled over by priest-kings from two main seats of government—the two capital cities of Harappa and Mohenjo-daro—linked by a great navigable river, Indus, with its five tributaries, which formed the main artery of communication between them. These priest-kings seemed to exercise an absolute and autocratic power. From this it follows that there should have existed an organised system of peasantry to produce food for the large population of these cities and of smaller towns of the kingdom. Of this, however, there is little direct evidence. Curiously enough, there is also no evidence of large temples or palaces. This seems to imply that worshipping in household shrines rather than congregational religious rites in temples was the system in vogue. Many features of the Harappan religious rites and worship are still retained in the Hindu society as their derivation from the Aryan traditions cannot be easily accounted for. The people who had developed this Indus Valley Civilization, it is believed, were of mixed origin and diverse types though there is still some controversy about it.

An idea of the knowledge of chemistry, acquired by the Indus Valley people, can be obtained from a consideration of the pottery vessels, articles of faience, beads, metallic objects, etc. that have been brought to light as a result of the excavations. These will now be discussed in somewhat greater details.

Indus Valley Pottery

We shall consider the pottery first. The pottery of the Indus Valley sites is for the most part plain; produced on a

mass scale on a rapidly spinning potter's wheel, for purely utilitarian purposes It has got a particular type of characteristic of its own. This generally consists of a platter on a raised foot; usually described as an "offering stand" Potters' kilns have also been found within the residential areas of the city of Mohenjo-daro at its latest phase. These are circular in shape. The stoke-hole and furnace lie beneath a perforated floor, originally covered by a domed roof. Decorated and painted potteries were also made by the Harappan workers. These contain black designs painted on a deep red, lustrous slip The wares are of black-on-red type reminding strongly of a connection with the North Baluchistan wares—and also show striking similarities with the Kulli style painting of the South Baluchistan wares Some true polychrome potteries of exceptional variety have been found at Harappa and Mohenjo-daro These are painted in red and green on a buff slip and are possibly related to the polychrome wares of the Nal Culture of South Baluchistan *Cf* Fig. 7 (*a*, *b*, *c* and *d*) and Fig 8 (*a* and *b*)

The commonest wares manufactured on a large scale were, however, bricks, water-pots, vessels and jars. Bricks are all well-fired with a uniform size measuring normally 11 by 5.5 by 2.5 inches. Huge earthenware wheel-made jars, three feet in height, used probably for storing water or grain, have been found at Mohenjo-daro and Harappa

Faience is another important variety of pottery produced by the Indus Valley people. It is a vitreous substance with a glazed surface often coloured by the addition of suitable mineral matters, produced by firing a composition of some base mixed with a powdered glaze. This suggests contact with Mesopotamia where faience beads were quite common in those early days

The pottery wares, both plain and decorated, were made of a good variety of clay that burned pink or light red in colour Sometimes, however, a clay was used which burned gray. This clay might have been imported, though the wares were of local manufacture. It required little or no tempering.

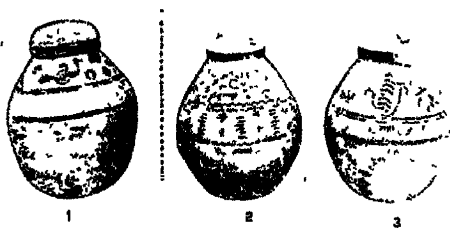


Fig. 7a.

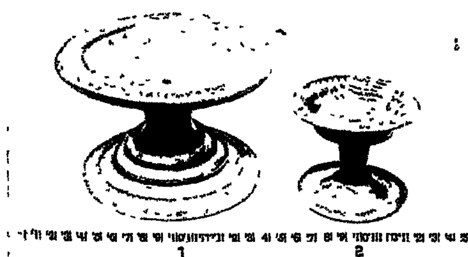
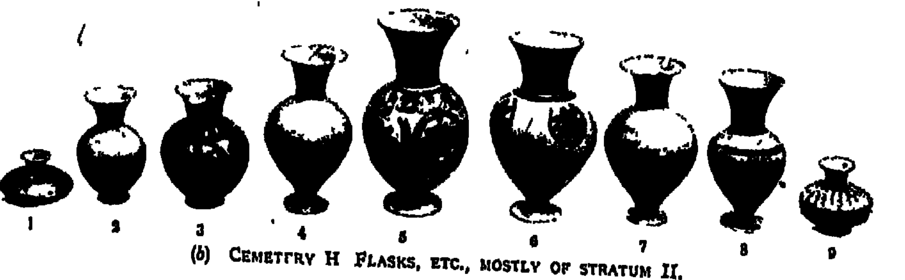


Fig. 7b

Potteries from Harappa (Vats, *Excavations at Harappa*, 1940).



(*b*) CEMETERY H FLASKS, ETC., MOSTLY OF STRATUM II.

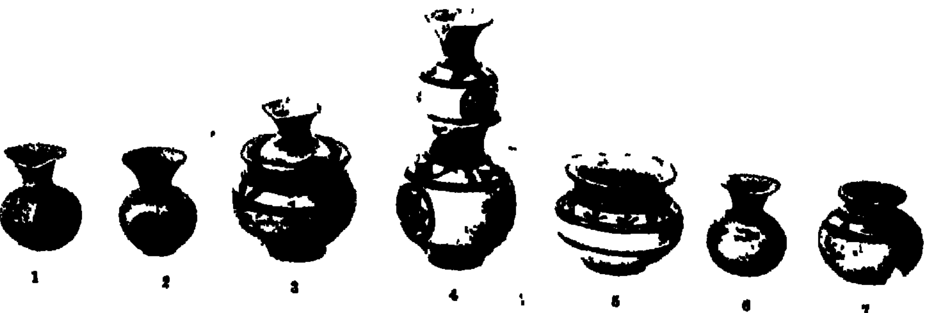


Fig. 7c. Potteries from Harappa (Vats, *Excavations at Harappa*, 1940).

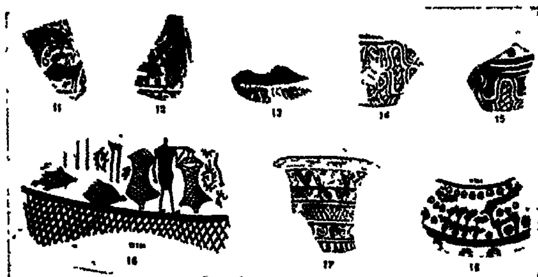


Fig. 7*d*. Potteries from Harappa (Vats, *Excavations at Harappa*, 1940).



Fig. 8*a*. Painted potteries from Harappa (Piggot, *Prehistoric India*, 1950).

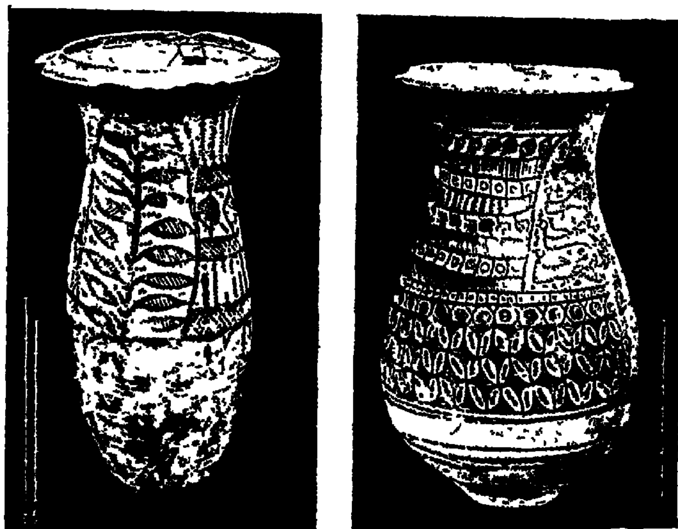


Fig. 8b Painted potteries from Harappa (Piggot, *Prehistoric India*, 1950).

A third variety of clay used at Mohenjo-daro produced a ware of very light pink colour and was of an exceptionally compact texture.

The tempering materials used with clay were mica, sand and lime. These were often used singly and rarely in combination. Mica is a very common substance found in the pottery wares as it betrays itself by its lustre. It is a common ingredient in the sand of the Indus Valley, from which it can be readily obtained by levigation. Its presence in clay facilitates the working of the latter on the wheel, and the drying of the pottery piece without cracking It, therefore, served as a useful tempering material. Lime is present in the fabric of both small and large Harappan jars Curiously enough it has been found to occur often in lumps of quite appreciable sizes. In fact, extra large fragments of lime have been flaked off the surface of some of the jars through the swelling due to slaking. These large particles of lime, in the opinion of Mackay, were mixed up with clay accidentally from the floor at the time of making the pots. A similar use of lime as a tempering material has been found in the wares of ancient Baluchistan, in some of the wares of Al Ubaid, Jemdet Nasr and in many of the predynastic wares of Egypt Opinions may differ as to the value of lime as a tempering material But with certain clays it seems to be an important ingredient and from the earliest times it has been mixed with them for this purpose.

The prevailing colours of the brick, pottery and miscellaneous terra-cotta objects found in such abundance at the Indus Valley sites are light red or salmon. Black or grey are rather rare. Sana Ullah (archæological chemist), in his analysis of these products, remarks that the colours are due to the presence of iron compounds in the clay, which develop a red shade in the oxidising atmosphere of the kiln, while black or grey products are obtained when a reducing or smoking atmosphere prevails in the course of burning. Analysis further shows that the slip of bright red colour sometimes found covering the pottery body is due to ferric oxide ; and the black or chocolate

designs, that are found painted on the body, owe their colour to oxides of manganese. This establishes an identity of the colouring agents used by the Indus Valley people with those used to-day by the Indian potters. Much of the ancient technique seems to have been handed down to the present time without alteration. The potters in India today prepare the red slip by levigating red ochre or *Multani matti* (a yellow ochreous earth) with water. For black or chocolate shades he employs a manganiferous hæmatite. The manganese oxides, frequently associated with ferric oxide, give a pure black colour when rich in manganese; when the proportion of iron in the mixture preponderates, a chocolate colour develops

A notable variety belonging to this colouring group is represented by a number of fine earthenware bangles usually black in colour, sometimes mottled white, but all characterised by the vitreous texture At Harappa, a dark red variety of earthenware bangles has been found. The chemical analysis of one of the specimens by Sana Ullah reveals .

Silica	53.28	per cent
Alumina	19.63	"
Ferric oxide	—	—
Ferrous oxide	8 70	"
Manganese oxide	0.13	"
Lime	9.63	"
Magnesia	4.39	"
Alkalies	3.43	"
Copper oxide	—	—
Water	—	—

The proportion of lime and magnesia are rather large. They account for the fusibility of the clay and vitreous body of the specimens. The black colour is due to ferrous oxide which also indicates the occurrence of a reducing atmosphere during the firing

Chemical analysis of a few other ceramic materials found at Mohenjo-daro may be given here (Table 1).

TABLE I

Specimen	Silica	Alumina	Ferric oxide	Ferrous oxide	Manganese oxide	Lime	Magnesia	Alkalies	Copper oxide	Water	Analyst
Greenish pottery	52.39	17.03	—	2 29	—	15.78	4 45	1 71	—	1 05	Sana Ullah
Faience bangle	88.12	3 02	1.82	—	—	1 26	—	Na_2O, 4.5 K_2O, 0.65	0 46	—	"
Faience vase (bluish green)	89 76	3.86	—	—	—	0.88	trace	4 07	0 50	—	"
Faience (chocolate)	91 07	2.44	—	—	trace	1 28	trace	2 08	1 98 (Cu_2O)	—	"
Steatite faience disc	57.99	4.85 (Alumina and Ferric oxide together)		—	—	4 31	27.20	3.54	1.09	2.01	Hamid
Steatite faience statuette	57 23	3.69	—	—	—	6.39	28 99	1.88	0 46	1 36	"
Slip from steatite seal	61.2	2.40	—	—	—	—	34 60	—	—	1 8	Sana Ullah
Steatite flat beads	63 65	—	—	—	—	—	33 80	—	—	1.09	"

The pottery articles of the Indus Valley are found to be all well-baked. The resulting fabric was hard enough to withstand considerable knocking about. The uniformity of the colour indicates that the potter had sufficient control over the heat of his furnace. Even in the case of larger storage jars often as much as 1 02 inches thick, this uniformity of colour was maintained right through. Very few over-heated vessels were noticed by Mackay among the findings, the number of under-fired ones was also rather small Some few over-fired specimens have a greenish tinge due to the presence of ferrous compounds, in whose formation time plays an important part.

Mackay reports of two curious pottery kilns found at Mohenjo-daro Their diameter at the top measured some 3 ft. 3 in The flat base of one of the kilns was, however, 2 ft 10 in in diameter · the diameter of the base of the other was 3 ft. 2 in. But the depth of both the kilns was 4 ft 3 in. They were paved with brick and round the inside of each was a 4 inch ledge The top of the kilns was only slightly above the level of the door-sill on the side The vitrification of the mud walls of these pits shows that they were used to fire articles at a high temperature. The fuel used was either wood or charcoal, the white ashes of which are still to be seen. The ledges mentioned above were probably intended for the support of a crucible or, if it be supposed that the kilns were used for glazing, a grating might have rested on the circular ledge. According to Mackay these kilns were probably used for objects more fusible than copper, because of their lack of draught or vent in the lower portions But there is no definite evidence about it (Fig. 9).

At Harappa three types of furnaces have been found · (a) round, (b) cylindrical pits dug into the ground with or without brick lining, (c) pear-shaped pits also dug into the ground with or without brick lining. The brick-lined ones are plastered with mud mixed with sand. It appears that the firing was not uniform; varying degrees of heat were

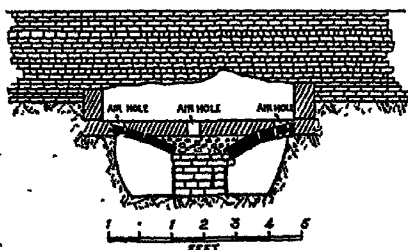


Fig. 9 Pottery kiln from Mohenjo-daro (Mackay).

used with evidence of intense heat in some of the furnaces, provided by vitrification of the walls. Repeated mud-sand plastering gives an indication of repeated use.

Glazed pottery found at Mohenjo-daro represents, according to Mackay, the earliest specimens in the world. In Egypt the practice of glazing started at a later date; in Mesopotamia the art appeared round about 1000 B. C. Faience was, however, extensively produced in the Indus Valley. It occurs frequently both in the higher as in the lower levels of the excavation.

Being of opinion that the glazing of pottery is probably Indian in origin, Mackay writes:

"It is certainly interesting to find that glazed pottery was used in India before it appears to have been known in Mesopotamia. And it should be noted that the quality of the Indian sherds that I have just described is equal in finish to any glazed ware of ancient Mesopotamia. The four pieces found at Mohenjo-daro are beyond all doubt the handiwork of a potter who was well acquainted with the process and able to carry it to a high degree of perfection'.

The microscopic examination of faience objects at Mohenjo-daro reveals a compact granular structure, composed of angular quartz grains They are bound together with a transparent cement. A chemical analysis of these objects also

shows that silica is the chief constituent (Table I), forming about ninety per cent of the total amount. It may, therefore, be inferred that the composition of the original paste was finely crushed quartz or pure white sand, a glassy flux and, if necessary, a colouring matter. The moulded object had to be dried and fired in order to bring about the fusion of the flux Curiously enough, analysis shows absence of clay which might have given coherence and plasticity to the paste for working and moulding. It is suggested by some authorities that probably silicate of soda, which forms a highly viscous solution with water, was used as a constituent of the paste. This served to impart the desired property to the wet paste. The practice of preparing an alkaline silicate by the fusion of soda with sand was well known to the ancient peoples who practised the art of glazing. The hollow objects were possibly moulded on cores of sand, which was held in some fabric and raked out after firing. Impressions of the fabric as well as remains of the sandy core, have been detected in several specimens

The white body is free from any metallic colouring matter and forms the basis for the coloured varieties. Analysis shows that those having blue and green shades contain copper oxide, which was added to the paste probably in the form of a natural ore. This also served to produce a chocolate coloured ware when heated in a reducing atmosphere of the kiln, due to the formation of cuprous oxide. The light red variety containing ferric oxide was probably produced by the addition of red ochre to the raw paste Most of the glazed pottery specimens have faded by weathering to a light blue or green colour. The granular white body material has been found, however, to often contain black specks. These may be the carbonized remains of an adhesive that was found necessary to hold the ingredients of the paste together before it was dipped in, or painted with the glaze.

Apart from quartz as body material, both powdered and carved steatite were also used. Analysis of two such specimens has been recorded in Table I. Powdered steatite, however,

does not seem to have been used in ancient Egypt for this purpose. It has been suggested that instead of adding any silicate to hold together the powdered steatite before firing, the object might have been extracted from its mould while still damp and, after being coated with the glaze, was heated in an increasing temperature until the fusing of the glaze bound the whole mass together.

The practice of cutting objects from solid stone and then glazing them was frequent in Mohenjo-daro. It was common also in Egypt.

Most of the glaze on the steatite objects found at Mohenjo-daro has disappeared by weathering and very few of them have been found unbroken and whole. They are generally of small size. Some of these were probably used for keeping cosmetics. On examining these articles it is found that the glaze has generally penetrated well into the body both on the inside and outside of the object. In a few cases it was also found that a certain amount of frit was mixed with the paste itself and was also applied to the ware both inside and outside. This undoubtedly strengthens the articles. We thus find that the Indus Valley potters generally used quartz and ground carved steatite as the body material for their glazed pottery.

Seals

Though these do not come correctly under the category of pottery, it might be convenient to discuss them here in connection with glazed wares.

The seals found at Harappa and Mohenjo-daro are coated with a smooth glassy-looking substance, resembling a glaze. No colour was detected on any of these seals. The surface coating on one of these seals was analysed with the following results by Sana Ullah:

Silica .	61.20	per cent.
Oxides of aluminium and iron .	2.4	"
Lime	—	—
Magnesia	34.6	"

The surface substance is steatite or talc. The body and the coating of the seals are of the same material. But the coating might have been an applied one, as it scales off just like a slip.

Perhaps before engraving a seal it was coated in order to conceal blemishes and then fired in a kiln like pottery-wares. The seals found cannot, therefore, be regarded as examples of glazed pottery.

A vitreous paste seems to have been used for the glaze. Slabs of this material have been found at Harappa and Mohenjo-daro. It resembles glass in some respects, and shows a smooth fracture; but it is opaque. An analysis of this vitreous paste by Sana Ullah shows its composition as follows

Silica	88.12 per cent.
Aluminium oxide	3.12 „
Ferric oxide	1.82 „
Lime	1.26 „
Alkalies	5.04 „
Cupric oxide	0.46 „

The mixture was probably fired at about 1200°C

Another slab of cornelian blue colour on analysis by Hamid (archæological chemist) gave the following results.

Silica	84.66 per cent.
Ferric oxide and alumina	6.31 „
Lime	1.40 „
Magnesia	trace
Alkalies	5.48 „
Oxide of copper	0.97 „
Loss on ignition	1.18 „

Many other slabs of similar composition have been found. These were probably ground to powder like the modern enamels, and used for glazing purpose with the addition of a

little soda to serve as a flux. In the case of steatite bodies, there must have been serious difficulties to make the resulting powder adhere properly to the surface of the body. It has been suggested that to overcome this, the powder might have been mixed with certain oils, which would volatilize at high temperatures leaving no trace behind: or, the slabs might have been heated to a semi-fluid state and then applied to the body of the material to be glazed, followed by a prolonged heating of the object in order to make the glaze flow freely over it. The layer of the glaze has, in fact, been found generally to be smooth and thin No evidence of over-firing has, however, been detected, which would produce a matt or pitted surface.

In the case of a few other bodies, an impression of a canvas-like material has been found on the surface below the glaze. It is suggested that this served as a backing to hold together the ingredients of the paste constituting the body of the ware, preparatory to glazing. The canvas-like material was subsequently burnt away in the kiln. The glaze has, however, been found to penetrate well into the paste forming a hard but somewhat brittle material. It is also likely, as assumed by Sana Ullah. that the glazing was carried out in a second firing as at present. The prevailing colours of the faience glaze of the Indus Valley wares are bluish green or greenish blue, although indigo blue, apple green, maroon, black and colourless examples have been found. The blue shades owe their colour to copper oxide, while green contains iron oxide in addition. The black or dark maroon glaze contains an excess of manganese oxide.

As a result of a careful examination of a number of specimens of glazed pottery Mackay has been able to throw a considerable amount of light regarding the methods employed in their preparation. Two pieces of sherds resemble very much copies of mosaic glass. But no true glass has yet been found either at Mohenjo-daro or at Harappa. Both of these are made of a light grey clay of medium thickness which is well baked and is tough. A certain amou

white sand or quartz is present in the body as well and a certain amount of charcoal. A purplish black slip constitutes the dark wavy markings. The method of painting patterns seems to have been first coating the pottery pieces with this dark slip and then washing them so as to leave a wavy pattern. There is a parallel of this curious technique in a painted pottery sherd found at Kish by Watelin.

We may now summarize about the pottery wares of the Indus Valley Civilization. Brown glazed pottery articles formed the most common variety. Some polychrome pottery objects, decorated with floral and geometric patterns in black and white, on a red ground, have been found. The base of some vases has a row of lotus petals as an adornment. Potteries in some cases were slip glazed, but mostly painted. Painted potteries were generally made by painting or decorating on a slip applied to the body. Slips used were also coloured buff, cream, pink and red. These were made mostly of ferruginous clays, or by mixing red ochre with clay. The articles were finally burnt. Manganiferous hæmatite was used for black colour, and gypsum for producing white pottery.

Lime and Mortars

The mortars used by the Indus Valley people consisted mainly of mud. But in the later periods gypsum cement of a light grey colour was employed for painting the walls of certain buildings at Mohenjo-daro. The gypsum used contains a considerable proportion of sand and clay, and a trace of calcium carbonate. A high percentage of lime has been found in an exceptionally well-constructed drain of the intermediate period at Mohenjo-daro. Analyses of certain samples of mortars collected from different spots and sites are given in Table II. It will be observed that these mortars were made generally of gypsum, lime and sand.

TABLE II

(Mortars)

Localities	Gypsum	Carbonate of lime	Sand	Alkaline salts	Moisture	Analyst
Wall	74 12	2.50	20 41	1.18	1 79	Sana Ullah
Do	63 25	0 66	31.61	3 47	1 01	"
Tank	43.75	13 78	38 04	2 47	1.96	"
Drain	56.73	27 87	16 64	—	1 76	"
Vat	nil	69 58	21.71	5.44	3 27	Hamid
Drain and cess pit	nil	31.96	46.74	0.74	3 74	Sana Ullah
	'	8.82 (magnesium carbonate)				
Painting of circular platform	59.90	0.94				"
Concrete floor	trace	37 63 2 18 (magnesium carbonate)				"
Brick floor	nil	26 50 34.80 (magnesium carbonate)				"

Metal and its Working

The urban civilization of the Indus Valley belongs formally to the Bronze Age, since copper and bronze were the only metals that were used for making tools and weapons. The findings at the Indus Valley sites prove that the metal workers of the two capital cities of Mohenjo-daro and Harappa were very skilful and had a plentiful supply of copper, silver and gold. Uses of lead and tin were not uncommon though the latter metal occurred always alloyed with copper in the form of bronze.

Copper and bronze were most frequently used for domestic utensils, axe-heads or celts, for daggers, knives, lance-heads, arrow-heads and sickles (Fig. 10). They were also used for statuettes, bangles finger-rings, ear-rings, and amulets, as well as for wires and rods Bronze was preferred to copper for making weapons and implements with extra sharp cutting edges (Figs 11-*a*, *b* : 12-*a*, *b*). It contained, as the analysis shows, a high percentage of tin (approximately 10 per cent) added either accidentally or deliberately Tin and copper ores, which are often found together, give rise directly to bronze on smelting. An alloy of copper and arsenic (3-4.5 %) was also used in place of bronze. The presence of arsenic might have been accidental, but it increased the hardness of the metal It might have been derived from the use of arsenical copper ores. Indus Valley copper has been found to contain normally a little nickel (usually below 0 5 per cent and seldom exceeding 1 per cent).

Some representative analyses of copper and bronze articles found at Mohenjo-daro and Harappa are given below (Table III).

A large hoard of copper and bronze implements contained in a copper pot securely covered by an inverted dish has been found at Harappa These on analysis were found to contain varying quantities of arsenic, nickel and lead.

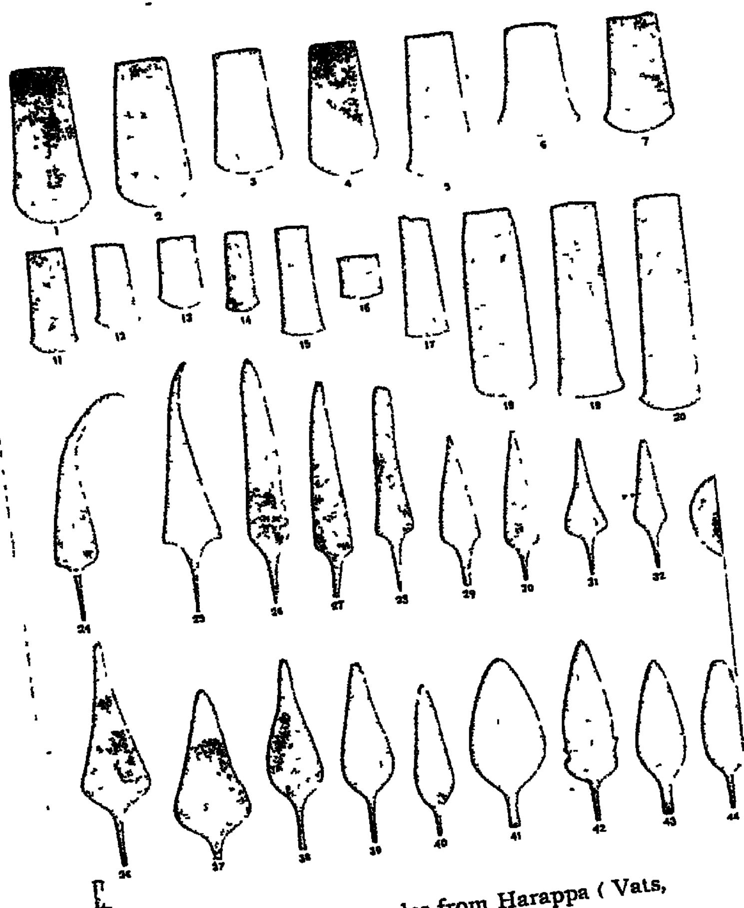


Fig. 10 Copper articles from Harappa (Vats, *Excavations at Harappa*, 1940).

Fig. 11*a*. Copper and bronze articles from Harappa (Vats, *Excavations at Harappa*, 1940).

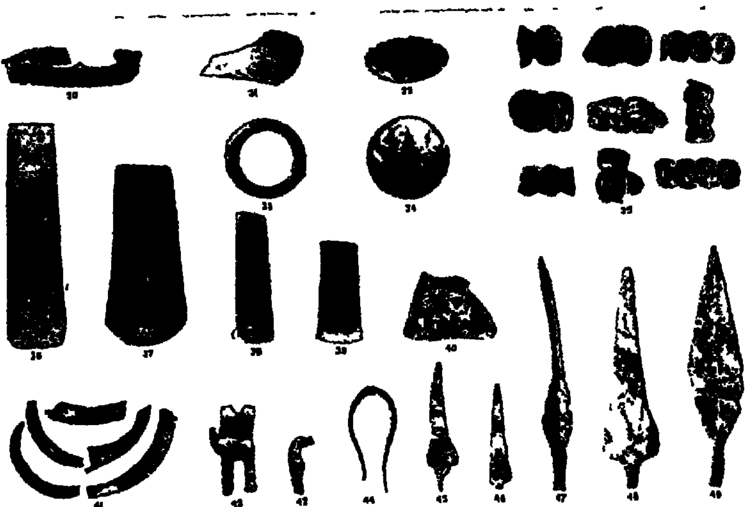


Fig. 11*b*. Copper and bronze articles from Harappa (Vats, *Excavations at Harappa*, 1940).

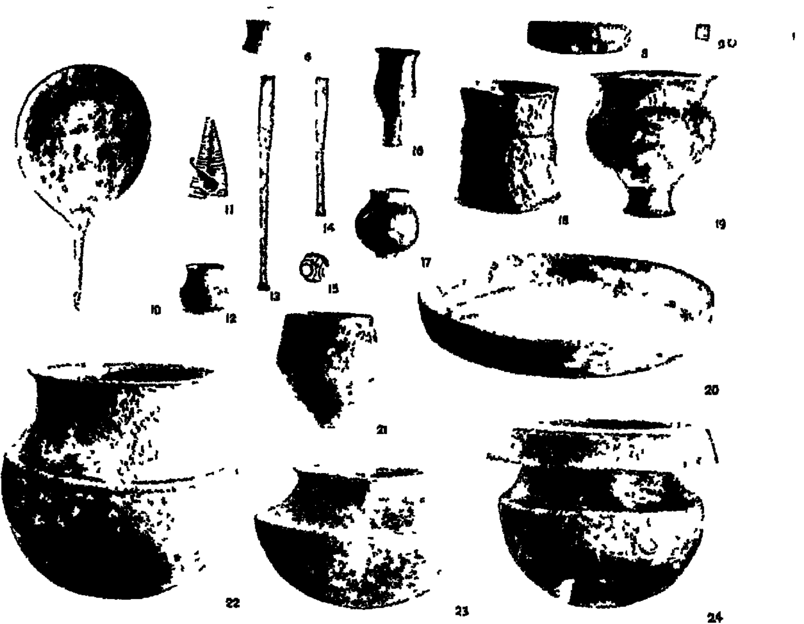


Fig. 12*a*. Copper and bronze objects from Mohenjodaro (Mackay, *Further Excavations at Mohenjodaro*, 1938).

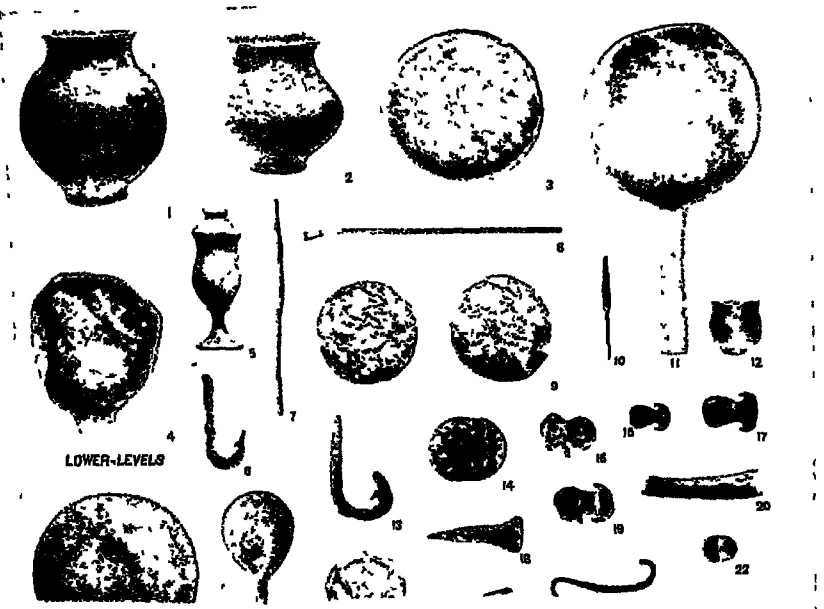


Fig. 12*b* Copper and bronze objects from Mohenjodaro
(Mackay, *Further Excavations at Mohenjodaro*, 1938).

TABLE III

Specimen	Copper	Tin	Antimony	Arsenic	Iron	Nickel	Lead	Sulphur	Oxygen	Remarks	Analyst
Copper lump I	96.67	—	0.88	0.15	0.03	1.27	0.02	0.18	—	Unaltered	Sana Ullah
Copper lump II	92.49	0.37	trace	1.30	1.51	1.06	trace	2.26	1.01	Partly oxidized	"
Fragment of some implement	95.80	—	0.72	0.74	0.12	0.25	1.58	0.61	0.18	Unaltered	"
Copper chisel	92.41	—	0.10	3.42	0.59	0.15	3.28	0.05	—	"	"
Bronze button	88.05	8.22	2.60	trace	0.29	trace	—	0.84	—	"	"
Bronze slab	82.71	13.21	0.33	1.17	0.42	0.56	0.11	—	1.49	Partly oxidized	"
Copper object	94.64	0.31	0.06	0.40	0.28	0.33	0.71	0.69	2.58	"	Hamid
"	97.23	—	—	0.24	0.29	0.89	0.81	0.10	0.44	Slightly oxidized	"
Bronze object	90.18	7.66	0.43	—	0.50	0.20	0.95	0.07	—	Unaltered	"
"	88.49	9.88	0.14	—	0.10	0.30	0.22	0.06	0.81	Slightly oxidized	"
Spear head	97.66	—	—	0.06	1.11	0.14	0.70	—	—	Unaltered	Sana Ullah
Celt	98.37	0.09	—	1.40	0.02	0.10	0.11	—	—	"	"
Needle	92.55	1.29	—	2.90	0.20	0.21	3.72	—	—	"	"
Dagger	91.00	6.76	0.44	0.04	0.74	0.14	0.58	—	—	Completely oxidized	"
Chisel (?)	87.42	10.45	—	1.10	0.34	0.17	0.52	—	—	Unaltered	"

Technique employed in the Indus Valley metallurgy included both casting and forging In the former process the metal had to be previously melted before being poured into a mould. Pure copper, when cast in a closed mould, becomes spongy due to the bubbles of free oxygen. But the addition of a very small percentage of tin or of arsenic acts as a deoxidizing agent. As most of the copper articles found at the Harappa and Mohenjo-daro sites contain these foreign metals in small amounts, their composition was quite suitable for production by casting But curiously enough the closed mould casting was never used for the production of tools in the Harappan Civiliza-tion. Most of the bronze objects were products of casting; some, however, had to be shaped and finished by hammering. This indicates that the Indus Valley metal-smiths were quite familiar with the properties of bronze that enable it to be forged at a temperature just below redness The analysis of bronze objects reveals an advanced state of knowledge of bronze-making on the part of their makers. Copper and bronze vessels have been found together which supports the assumption that they were in simultaneous use. This was presumably due to the scarcity of tin. Copper alloyed with arsenic was also used at Mohenjo-daro and Harappa, as copper-arsenic alloy is compa-rable with low grade bronze in hardness. As already stated, this alloy might have resulted accidentally from the use of arsenical copper ores for the extraction of the metal. There are evidences that copper articles, such as axes, were made both by casting and hammering; the edges were usually hammered out after plain blades had been cast.

Copper was possibly smelted from ores near the mines, the metal being afterwards refined in clay crucibles. A fragment of such a crucible with the slag sticking to the edges has been found at the excavation at Mohenjo-daro. From an examination of the analytical results, given above, of specimens of various articles found at the Indus Valley sites, it may be concluded that the people at that time were acquainted with four distinct varieties of copper and its alloys: viz. (a) crude

copper, (*b*) refined copper, (*c*) copper-tin alloy or bronze and (*d*) copper-arsenic and copper-arsenic-lead alloys.

(*a*) Crude copper, the first product of the smelting furnace, was too rich in sulphur to be worked up by hammering and was suitable only for casting heavy and plain objects.

(*b*) Refined copper, on account of its purity and ductility, rendered it quite suitable for making vessels of elaborate shapes, as also for obtaining sound casting in closed moulds. The presence of small amounts of arsenic and antimony imparted appreciable hardness to the metal.

(*c*) The percentage of tin in the bronze articles found at the Indus Valley sites lies between 4.51 to 13.21. Those with 11-13 per cent of tin are more common, although lower grades also occur to some extent. The presence of the high grade alloys well-suited for sharp-edged tools, with a fairly regular proportion of tin, leaves hardly any doubt that the addition of the white metal was intentional and not the result of mere accident. Tin was possibly imported from outside, likely from Persia. It is obvious that this stage in metallurgy had been reached after prolonged experimentation and experience with copper and its alloys with arsenic and tin. An appreciable amount of antimony and arsenic has been found in many bronze articles, which thereby gain an increased hardness.

(*d*) Copper-arsenic alloy was employed as a substitute for low grade bronze. Presence of lead in copper and bronze tended to increase their fusibility, rendering the latter more suited for casting. But it was more probably an accidental impurity than an intentional addition. Copper ore is unknown in Sind. The nearest deposits are to be found in the countries bordering on the west of the Indus Valley. In Baluchistan rich copper ores occur at Shah Ballaul and at Robat. Here large heaps of copper slags have been found indicating ancient smelting at these sites. Perhaps the ores were mined and smelted here and then transported to the cities of Harappa and Mohenjo-daro. The evidence of the extraction of copper is still to be seen at the various village sites belonging to the

Mohenjo-daro Period of history that have been uncovered in Baluchistan Deposits of copper ore also occur at Râs Kuk and the Kojak Amran range in Baluchistan In Afghanistan there are rich veins of copper in Shah Maksud range In Persia there are copper deposits at Anarek and in Kaleh Zeri (Kerman) At both these places there are evidences of extensive ancient workings The nearest copper mines in India proper are those in Rajputana These are situated near Ajmere in Sirohi, in the Mewar and Jaipur states especially those at Khetri and Singhana bear the evidence of having been worked from very early times In the copper lumps found at Mohenjo-daro the small quantities of sulphur indicate the use of the sulphide ore, which abounds in these mines, for the extraction of copper. The presence of lead in some of the copper objects is also noteworthy Copper ores associated with lead occur in Rajputana and in the Hazaribagh district, as also in Afghanistan and Baluchistan. Samples of copper ores from Khetri, Alwar, Singhbhum and Afghanistan contain both nickel and arsenic, while those from Bilaspur and Nellore are entirely free from nickel It can, therefore, be concluded that the Indus Valley copper most likely came from the Indian ores in the Rajputana district and Baluchistan, though Afghanistan and Persian sources are not absolutely ruled out

It is believed that the furnaces employed for the smelting of copper ores were simply a concave depression in the ground Kilns have not yet been identified with certainty There is evidence that charcoal was used as a fuel The pits were lined with clay. A layer of charcoal was probably first placed on the floor of the pit and ignited Over this the ore and charcoal in alternate layers might have been arranged and the firing maintained by the aid of a blast

The use of gold was confined to jewellery in the Indus Valley, while silver was used for jewellery and also for ornamental vessels Gold was obtained from South Indian gold fields in Mysore and Madras Silver might have been obtained with gold from the same source or from argentifer-

ous lead of Burma. Articles made of gold-silver alloy, electrum, have also been found at Mohenjo-daro. A sample of silver found at Mohenjo-daro has been found on analysis by Hamid (archæological chemist) to contain

Silver	94 52	per cent.
Lead	0 42	,,
Copper	3.68	,,
Insolubles (silver chloride etc.)	0.88	,,

This seems to indicate that the silver was obtained by smelting argentiferous lead ore associated with cuprite of which the cerussite, found at Baluchistan, might be a probable source. The process of extracting silver from lead was undoubtedly known to the people of the Indus Valley. Silver might have been obtained also from Afghanistan and Persia From Persia, too, gold may have been obtained and more certainly tin and lead.

Minerals

A large number of minerals, ores and rocks were known to, and in use among, the Indus Valley people. These include lapislazuli, turquoise, rock crystal, limestone, soapstone, alabaster, hæmatite, amethyst, slate, agate, jasper, chalcedony onyx, bitumen, steatite, sodalite, jade, lollingite, arsenical pyrites, etc Most of these were found in the form of beads, pendants, etc. for ornamental purposes, and some like steatite were often coated with a glaze. Lollingite and leucopyrites were also utilized for the preparation of arsenious oxide and arsenic. Cerrusite and cinnabar have also been found at Mohenjo-daro They were probably used for cosmetics and medicinal purposes. White lead was possibly utilized for plasters, eye-salves and hair-washes. Galena was employed for the preparation of eye-salves and paints.

Bitumen, alabaster and steatite were probably obtained from Baluchistan. Turquoise and lapislazuli are certainly of

Persian or Afghan origin. Hæmatite was imported from the islands of the Persian gulf. Agates, carnelians, onyx and chalcedony, as also rock crystal, were obtained from Kathiawar region. Rajputana is most likely to have provided steatite, slate, jasper, chalcedony, etc.

Dyeing

Finally, it might be mentioned that evidence has been obtained that the Indus Valley people were acquainted with the art of dyeing cotton with the red colouring matter of the madder root.

CHAPTER III

POST-HARAPPAN PERIOD

(Circa 1800 B.C—1500 B.C)

The great urban civilization of the Indus Valley and the earlier agricultural communities of the Baluchistan hills had an almost uninterrupted duration for seven to eight hundred years. There is evidence according to Piggott that the Baluchi settlements and the great cities of the Harappan Kingdom were then sacked and burnt by the barbarian invaders from the west. Refugees from these invaded sites migrated towards the east and made temporary settlements on the Gangetic Plains and the hilly regions to the south-east. This happened probably after 2000 B.C. but before 1500 B.C.

The explorations at Shahi-tump, Chanhu-daro and Jhukar in the Southern Baluchistan by Mackay and Majumdar show the development of a distinct culture in those regions as a result of intermingling of the new comers with the earlier residents. This is best illustrated in the finds of pottery, iron and copper implements there (Figs. 13 and 14).

In the Gangetic basin and on the uplands to the south-east quite a large number of copper tools, sometimes in hoards of 400 or more objects, have been found, notably at Gungeria, Balaghat (C. P.), in the valleys of the Ganges and the Jumna, and at or about the Ranchi uplands. They consist mostly of flat copper or bronze axes and the elongated axes or chisel called 'bar-celt', besides a number of copper harpoons. These seem to suggest a colonisation of the Ganges' basin and the neighbouring hilly and forest regions by the refugees and the displaced persons from the Indus Valley, when the Harappan Empire broke up as a result of barbarian invasion from the west. The deposition of hoards suggests a time of instability and insecurity, as the panicky refugees were retreating from the pursuit of barbarian invaders.

Some of the characteristics of these deposits are noted below.

At Gungeria in the district of Balaghat in the Nagpur Division of the Central Provinces 424 copper implements and 102 pieces of thin silver plates were discovered in one place in an area measuring 3 ft. long, 3 ft. broad and 4 ft deep The copper implements were mostly celts, shovels, axe-blades, spades, etc. They were found closely packed together indicating secret storage They are made of copper and not bronze, containing only 1 5 per cent of lead. The silver was also found to be admixed with 3.7 per cent of gold.

A list of some of the other sites, where such hoards have been found, is given below along with an indication of their contents.

	Locality	Contents of Find
1.	Rajpur, Bijnor Dist., U. P	16 objects :—celts, bar-celts, barbed spears or harpoon heads
2	Fategarh	13 swords (with human figure).
3.	Parior (Unao Dist)	A large number of harpoon heads.
4	Bulandsher and Hardoi Dist.	10 copper implements
5.	Manbhum Dist., Bihar	27 specimens of copper axe-heads
6.	Ranchi Dist.	21 copper axes
7.	Mayurbhanj State, Orissa	10 pieces of double-edge copper battle-axes.
8	Karharari, Pechamba Sub-division, Hazaribagh Dist.	5 pieces; unfinished celts and unwrought copper.

The copper implements of Gungeria bear unmistakable signs of having been hammered after the objects were cast in a mould. The finds at Karharari (Pechamba Sub-division, Hazaribagh Dist.) were first rough cast as blooms and then hammered into shape as celts.

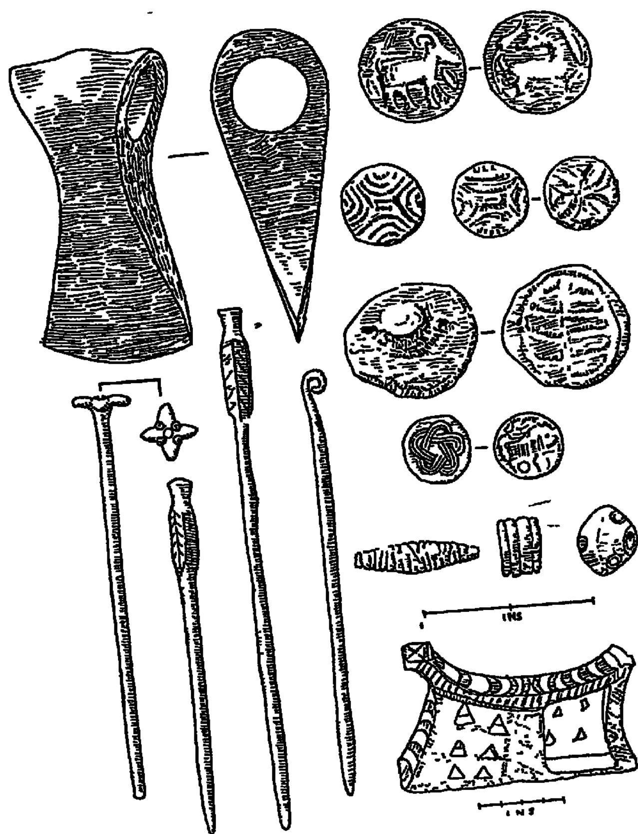


Fig. 13. Copper axes, pins and potteries from Jhukar (Mackay, *Further Excavations at Mohenjodaro*, 1938).

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Fig 14 Potteries and iron implements from Jhukar (Majumdar, *Explorations in Sind, Memoirs, Archaeological Survey of India*. No 48)

In the opinion of the archæologists, these migrations of peoples occurred at a time when the Indus Valley Civilization broke up at the advent of the barbarian raiders. But the invaders after their settlement utilized the traditions of the local craftsmen and introduced some new ideas, and even perhaps new techniques, to the framework of the ancient civilization.

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VEDIC AND AYURVEDIC PERIOD

(Circa 1500 B C to 800 A D)

CHAPTER I

VEDIC PERIOD

(Circa 1500 B C to pre-Buddhistic era, 600 B C)

After the decline of the Indus Valley Civilization as a result of the inroads of war-like and nomadic tribes from the north-west, there is little evidence of any intellectual and cultural activities in India till the advent of the Aryans, a member of the so-called Indo-European group of peoples, who might be said to represent the last phase of the folk-movement that affected India in that early age. This happened at about 1700 B.C., as the archæological, linguistic and other evidences seem to suggest. The Aryans, to begin with, settled themselves in the North-West India, the region where the Harappan civilization flourished, and then gradually spread themselves towards the east along the banks of the river Ganges.

The Rigveda, the oldest composition and the sacred religious text of the Aryans, which was transmitted almost unaltered from generation to generation simply through oral traditions, memorizing and recital, furnishes us with a picture of the earliest Indo-Aryan culture. They were predominantly agriculturists, reckoning wealth in domesticated sheep, cows and horses ; they knew the uses of bronze, copper, gold and silver ; and they made use of wheeled chariots for rapid transport and warfare. They used to speak in Vedic Sanskrit—one of the original Indo-European languages, and were worshippers of anthropomorphic gods They were frequently at war among themselves and with the earlier inhabitants of the land, whom they subdued and derisively termed Dasyus or Dasas. They built up a society which was mostly priest-laden with division of labour that ultimately gave rise to the three main classes known as Brahmins, the priests ; Kshatriyas, the warriors and rulers ; and Vaisyas, the traders. Nevertheless, the Aryans

gradually imbibed and assimilated the religious practices, social customs and cultures of those earlier people, the so-called Dravidians or Dasyus, and even intermingled with them by marriages inspite of many rigid regulations for the preservation of the purity of the race.

The Rigveda is regarded as a genuine document of the period when the Aryans first established their settlement in India, i.e. of the 15th to 12th centuries B.C. and possibly of an even earlier period. From an examination of the material culture of the period as can be extracted from the hymns of the Rigveda combined with their interpretation in the light of archæological evidences, we can arrive at certain conclusions about their scientific ideas and practices. The Aryans, when they first came to India were mostly pastoral communities and, compared to the earlier Indus Valley people, much less advanced in cultural achievements. The Indus Valley Culture, based on complicated urban organization, constituted, so to say, a landmark in the annals of the early Bronze Age Civilization of the 3rd millenium B.C. In the Rigveda, we find the mention of only gold, silver, copper and bronze among metals or metallic objects. A hymn (1, 162) gives an account of the bronze cauldron slung over the fire by pot-hooks for the cooking of meat. Gold was used for ornaments like anklets, rings, etc. Mention of metal vessels, tools and armour, made mainly of bronze, affords evidence of the knowledge of metal-working. Some writers (including Neogi) believe that iron was known during the time of the Rigveda. For, according to them, the word *ayas*, which occurs in many hymns of the Rigveda, definitely refers to iron in certain instances. We cannot, however, subscribe to this view. Because we should not lose sight of the fact that *ayas* was used as a generic name for metals in the Vedic age, and sometimes also for gold. Then again in the Brahmanas and Upanishads, which were of later date than the Vedas (800 B.C.—500 B.C.), we find that the word *ayas* has been differentiated into *lohitayas* or red-metal and *krishnayas* or black metal, representing copper and iron respectively without any doubt. The very fact that this necessity was not felt during

the time of the Rigveda is a strong evidence against the view that iron was known in those days Besides, we have already seen that no article of iron has been found in the excavation at Harappa or Mohenjo-daro. So, the Aryans when they first entered India as nomadic tribes and agricultural communities could not have been unacquainted with copper and bronze That they were acquainted with iron and not with copper and bronze in the beginning is, therefore, a view that has little justification in its favour.

References are found in the Rigveda about the preparation and tanning of leather and hides for use as slings, bead-strings, reins and whips.

Very little information is available about the Aryan-pottery in the time of the Rigveda except of their use as vessels for various household purposes.

There is, however, plentiful mention of a number of fermented drinks. *Soma*, the fermented juice from the stems of soma plant, had been highly extolled and even worshipped or invoked as the representation of divine power It was, however, largely used during the religious rituals Among other fermented liquors, there is a mention of *madhu*, a drink supplied at feasts, and *sura*, which was probably a kind of beer brewed from barley grain Curds or fermented milk also constituted an important article of diet

It can be gathered from the texts that the cloths were mainly made of wool and the garments were often dyed red, purple and brown. Obviously the people were acquainted with the art of dyeing with certain natural vegetable colouring matters.

Following the Rigveda and related to it are the three other Vedas: the Samaveda, the Yajurveda and the Atharvaveda, whose composition has been assigned to the eleventh and tenth centuries B C., the Atharvan being the latest of the group

In the white Yajurveda we find, however, mention of six metals. It tells of *ayas* (gold), *hiranya* (silver), *loha* (copper),

shyama (iron), *sisa* (lead) and *trapu* (tin). The Atharvaveda, on the other hand, names gold as *harita* (yellow), silver as *rajata* (white), and copper as *lohita* (red).

The Atharvaveda consists mostly of charms, spells, incantations, magic, sorcery, demonology and witchcraft. It deals also with plants and vegetable products as helpful agents in the treatment of diseases and for the prolongation of life. In one hymn it refers to the soma plant as follows :

"The strength of this *amrita* (ambrosia) do we give this man to drink Moreover, I prepare a remedy that he may live a hundred years !"

There is also a distinct reference to a remedy for promoting the growth of hair in another hymn (VI. 163. 1-2.).

"As a goddess upon the goddess earth thou wast born, O plant ! We dig thee up, O nitani, that thou mayest strengthen (the growth) of the hair.

"Strengthen the old (hair), beget the new ! That which has come forth render more luxurious !"

In the Atharvaveda the hymns for the cure of diseases and of possessions by demons of disease are known as "bhaishajyani", while those which have for their object the prolongation of life and preservation of youth and health are known as "ayushyani"—a term which later on gave place to "rasayana" the Sanskrit equivalent of alchemy. As illustrations, we shall quote here two such hymns under the latter heading, which are in the form of invocations to pearl and shell and to gold respectively.

"Born in the Heavens, born in the sea, brought on from the river (Sindhu), this shell, born of gold, is our life-prolonging amulet."

"The bone of the gods turned into pearls ; that, animated, dwells in waters. That do I fasten upon thee unto life, lustre, strength, longevity, unto a life lasting a hundred autumns. May the (amulet) of pearl protect thee !"

"The gold which is born from fire, the immortal they bestowed upon the mortals. He who knows this deserves it ; of old age dies he who wears it "

"The gold, (endowed by) the sun with beautiful colour, which the men of yore, rich in descendants, did desire, may it gleaming envelope thee in lustre ! Long-lived becomes he who wears it !"

While gold was regarded as the elixir of life, lead was looked upon as the dispeller of sorcery. Thus a hymn tells us

"To the lead Varuna gives blessings, to the lead Agni gives help. Indra gave me the lead ; unfailingly dispels sorcery "

Thus we find that the origin of alchemical notions gathered round gold, lead, soma juice and other medicinal plants as early as the age of the Atharvaveda in India. And as the Vedas, the sacred scriptures of the ancient Hindus, enjoyed a very high canonical sanctity and were viewed more as revelations than as human compositions, there is no wonder that medicine and, for that matter, chemical knowledge as well in ancient India have seldom been able to shake themselves completely free from the influence of magic, religion and alchemy as auxiliaries For, chemistry in ancient India, possibly more so than in Europe, was evolved chiefly as a handmaid of medicine and, somewhat later on, as adjunct of the Tantric cult The efficacy of the drug alone was by no means considered sufficient unless backed by the kindly interpretation of the deities.

Hence both medicine and chemistry, particularly in their alchemical aspects, followed the course of religious practices in their development In fact, at no time they were free from theological tinge or urge. It had been a usual practice for the early workers and writers, while discussing theories or describing processes of chemical operations, to ascribe the origin thereof to their favourite gods and goddesses, or to start with a prayer to the presiding deity of the branch of

knowledge concerned. Each element and phenomenon of nature, as well as the properties of each substance, were associated or identified with their respective divinities responsible for their manifestation. The presentation of subject matter in many writings and works of the Ayurvedic and Tantric period will be found to have been made in the shape of a dialogue between the god Siva or Hara and his consort Parvati or Gouri. Where the authors of the works were Buddhist by religion, we meet with the name of a Buddha, a Tathagata or an Avalokiteswara being invoked as the revealer of all knowledge.

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CHAPTER II

AYURVEDIC PERIOD

(Circa 600 B C—800 A D)

The Constitution and Properties of Matter : Atomic Theory.

The Ayurvedic period constitutes the most flourishing and fruitful age of ancient India relating to the accumulation and development of knowledge in chemical science which, as already stated, was then closely associated with medicine. It will be observed that the medicine and chemistry of the period were dominated by the abstract theories of the Upanishads and the systems of philosophies developed during the post-Vedic age. This relates to the physical and chemical theories embracing the process of entire cosmic evolution and the methodology of science. We do not propose to discuss these theories in any detail here, as a separate section has been set apart for the purpose, which is more or less a reproduction of the article by B. N. Seal embodied in the second volume of the History of Hindu Chemistry

But as chemistry has to deal primarily with the composition and changes of matter, a concise preliminary summary of the salient features of some of these theories will be given here before we proceed to deal with the development of chemical knowledge of the period in its practical aspect

It may be stated at the outset that these theories were purely speculative in character with little or no experimental verification, being the result of only systematic and logical thoughts; yet they may be said to stand in good comparison with some of the most recent and advanced scientific ideas of our own time, and to bear the stamp of high intellectual perfection and sublime intuition. Two of the theories of cosmogenesis deserve particular mention in this connection.

One has been described in the Samkhya system of Hindu philosophies (circa 500 B.C.) and the other in the Chhandogya Upanishad.

The Samkhya-Patanjala View of the Process of Cosmic Evolution.

The Samkhya theory of cosmogony, which is also upheld by Patanjali in his Yoga system on all essential points may be viewed as possessing all the characteristics of a scientific hypothesis. For, it may be represented as based on the principles of conservation, transformation and dissipation of energy, as also on the conception of space *(desa)* and time *(kala)*. The idea of causality has also been elaborated in an advanced manner. It gives a comprehensive picture of cosmogenesis in both its material and metaphysical aspects

According to Samkhya the universe, as it is manifested to us, is evolved out of an unmanifested cosmic nature termed *prakriti* or *avyakta*, the ultimate ground. The latter is defined as an infinite, eternal, ubiquitous, indestructible, indifferentiated, indeterminate continuum. This was believed to be made up of infinitesimal *reals* or *gunas*, representing substantive entities. These entities are classified under three heads distinguished as *sattva*, the essence or intelligence-stuff, *rajas*, the energy-stuff, and *tamas*, the inertia or matter-stuff. These three *gunas* exist together in equilibrium or uniform diffusion in the infinite continuum, *prakriti*. It is indeed intriguing to note here that Samkhya attributes the character of both quantum (*parichchhinnatva*) and continuity or extension (*pariman*) to the energy-stuff as well as to the matter-stuff. It bears resemblance to our modern conception of energy and matter. In the beginning the cosmic nature or *prakriti*, the continuum, was in a state of perfect equipoise with all its *gunas* or stuffs in equilibrium or uniform diffusion. This represented the process of cosmic evolution under arrest. The process of evolution was then initiated by a disturbance of this equilibrium through the transcendental or magnetic influence exerted on the slumbering *prakriti* by *purusha*, the Absolute, often designated as the Soul,

the *atman*, or the transcendental self *Purusha* or *atman* is incapable of modification or affectation of any kind either as subject or object. The disturbance of the original equilibrium in the *prakriti* led to an unequal aggregation or collection of *gunas*, which represented a creative transformation accompanied by evolution of motion (*parispanda*) This evolution has been defined in Samkhya as the process of differentiation in the integrated whole. This proceeds in accordance with a definite law which it cannot violate or overstep. Cosmic evolution is considered in Samkhya as a two-fold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic. As by unequal aggregation of *gunas* the creation of organic and inorganic matter results, so there is a constant tendency on the part of the unstable equilibrium, produced by unequal aggregation, to revert to the original stable equilibrium of *prakriti* with the uniform equal diffusion of the *gunas*. This suggests a dissipation of the energy and the mass-stuff.

The totality of the *gunas* in the universe remains always constant, taking together the manifested and the unmanifested, the actual and the potential. It is only the changes or differences in their collocation or aggregation which are responsible for the diversity of phenomena and objects. This implies a principle of the conservation *of the mass-stuff and the energy*-stuff, as well as of their transformations The law of causation then follows directly from this.

The conception of space (*desa*) and time (*kala*), and the idea of causality, as elaborated in Samkhya, are of a surprisingly advanced character

The conception of cosmic evolution as advanced in the Chhandogya Upanishad is of an entirely different character. According to this, the universe in the beginning existed, so to say, in a highly refined or potential form like a seed or an embryo. This then changed into a grosser stuff, *ap* (water), which latter again changed into a still grosser body, egg. This egg, after a period of maturing, burst into two pieces, which

gave rise to the two worlds, the Heaven and Earth. This is obviously a very crude picture, but curiously enough, bears some resemblance to the modern theory of evolution based on the idea of expanding universe.

As we are primarily concerned with the theories of matter and its constitution, we should better confine ourselves to these, leaving aside for the present the metaphysical aspects of the Indian philosophical systems. We shall, therefore, proceed to discuss the atomistic conception of matter as formulated by the ancient Indians.

Kapila, the reputed originator of the Samkhya philosophy, believed to be the oldest of the six systems of Hindu philosophies, developed his ideas about the ultimate particles of matter in the latter part of his theory of cosmogenesis to which we have referred above. According to him five subtle or infra-atomic particles, named as *tanmatras* and imperceptible to human senses, were derived from the conscious principle, *bhutadi*—the super-subtile homogeneous matter rudiment, as a result of continued differentiation and unequal aggregation. These subsequently gave rise, by the same process, to the five grosser elements (*bhutas*) :—space or ether (*akasa*), air (*vayu*), fire (*tejas*), water (*ap*) and earth (*kshiti*). These five types of grosser elements should not be confounded with five different elementary substances in the usual sense. They are regarded as representing five abstract principles, or rather a classification of substances on the basis of their properties and states of aggregation. For instance, earth, water and air may be viewed as comprising all the so-called elements or compounds of chemistry. Thus, *kshiti* typifies all solids, *ap* all liquids, and *vayu* all gases. According to Samkhya, atoms (*anus*) of these grosser elements are composite units made up of infra-atomic particles (*tanmatras*). The difference in the properties of the same *bhuta* class is attributed by Samkhya to a difference in the grouping of *tanmatras* in the atoms (*anus*). The atomic theory of Samkhya bears a great resemblance to the Greek theory of elements introduced by Empedocles (490-430 B.C.).

Kanada, the founder of the Vaiseshika system of Indian philosophy, chiefly occupied himself with the study of the properties of matter and the nature of atoms and molecules The atomic hypothesis, as propounded by him, has many points in common with that of the Greek philosopher Democritus (470-360 B C.) Almost identical views are expressed in the Nyaya system of Hindu philosophy

The distinguishing feature of the chemical theory of the Nyaya-Vaiseshika system is the theory of *anus* or atoms. They are comparable to *tanmatras* of the Samkhya philosophy. The idea has been fully worked out by Kanada in the Vaiseshika.

Akasa (ether), according to Kanada, has no atomic structure; it is inert and ubiquitous serving only as the substratum of sound which is supposed to travel in the form of waves in the manifesting medium of *vayu* (air). Samkhya too conceived of *akasa* as the universal all-pervading medium in which air, light and heat corpuscles, and other atoms move and float about. Kanada, therefore, recognised four kinds of atoms; viz., the *kshiti*, the *ap*, the *tejas* and the *vayu* atoms, which correspond to the atoms of four gross elementary types of matter,—earth, water, fire and air, as taught by the Greek philosophers Regarding light and heat Kanada makes the remarkable statement that they are only the different forms of one and the same essential entity, *tejas* Kanada attributes to these atoms certain characteristic properties, such as number, quantity, individuality, mass, gravity, fluidity, velocity, elasticity, as well as certain characteristic potentials of sense stimuli like colour, taste, smell or touch According to him atoms are eternal and indestructible, though they cannot exist in free or uncombined state. As an aggregate or in the combined state they are, however, transient The qualities of *kshiti* are colour, taste, smell and touch, the distinguishing quality is, however, smell. *Ap* has the qualities of *kshiti* excepting smell and with the addition of viscidity, its distinguishing quality is coolness. *Tejas* has the qualities of *kshiti* excepting smell,

taste and gravity; its distinguishing quality is colour and hotness. *Vayu* has the qualities of *kshiti* with the exception of smell, taste and colour; its distinguishing quality is touch.

Combination of Atoms

One atom unites with another under an inherent impulse to form a binary molecule or a compound of two atoms. The atoms possess an intrinsic vibratory or rotatory motion (*parispanda*). Atoms of the same *bhuta* uniting in pairs give rise to molecules with homogeneous qualities corresponding to the original quality of the atoms, provided that no chemical change under the action of heat corpuscles takes place. This obviously represents the formation of binary molecules of elementary substances according to our modern conception. The binary molecules then combine among themselves by groups of three, four, five, etc., to produce larger aggregates in obedience to the moral law underlying the creation. The variety of elementary substances is thus originated. Another view of the same school, however, maintains that some atoms may unite in pairs, some in triads, others in tetrads, etc, either directly or by the successive addition of one atom to each preceding aggregate. This leads to the formation of binary, ternary, and quarternary molecules, etc. The variety of substances of the same *bhuta* class, say of the earth substances, is thus the consequence of the difference in their molecular composition and configuration with the development of different specific qualities.

An elementary substance, thus produced by primary combination, may, however, undergo qualitative transformation under the influence of heat corpuscles The process consists of the following changes in order·

(1) Their decomposition into the original homogeneous atoms, (2) a transformation of the character of the atoms, and (3) the re-union of the transformed atoms into different groups or arrangements with development of new characteristic properties.

Combination may also take place either between atoms of two or more substances belonging to the same *bhuta* class or of

those of different *bhuta* classes. A classification on this basis giving the following order of compounds has been made.

(A) *Mono-bhautic* compounds :—These are the simplest ; i. e., compounds formed by the union of homogeneous atoms of different substances which are isomeric modes of the same *bhuta* class

(B) *Hetero-bhautic* compounds —These may be bi or poly-bhautic compounds formed by the union of heterogeneous atoms of substances belonging to the different *bhuta* classes.

The characteristic of Kanada's atomic theory is the assumption of the atoms as the indivisible ultimate particles of matter with eternal life They are thus indestructible. Though eternal in themselves, they are, however, non-eternal as aggregates. As aggregates they may be organic and inorganic. Atoms are also conceived of as spherical in shape. According to Kanada, the variety of substances of the same *bhuta* class, as well as mono and poly-bhautic compounds, result from variation in the collocation of atoms and configuration of molecules. Thus a conception of the arrangement of atoms in space constitutes an essential part of Kanada's theory of chemical combination.

The Atomic Theory of the Jainas

The atomic theory of the Jainas (circa 40 A.D) is characterised by a very remarkable and interesting contribution to the subject of chemical combination. It relates to their analysis of atomic linking and the mutual attraction or repulsion of atoms in the formation of molecules. The Jaina system of philosophy holds that the different classes of elementary substances (*bhutas*) are all made up of the same primordial atoms. Hence, the same kind of interatomic forces is involved in the formation of chemical compounds, as well as of molecules, from atoms

According to the Jainas mere juxtaposition of atoms or molecules is not sufficient to bring about chemical combination. An interlinking between atoms or molecules must precede all compound formation. Matter (*bhuta*) in the Jaina philosophy

is called *pudgala*, which exists in two forms: *anu* (atom) and *skandha* (aggregate). Linking is possible only between two particles of matter of opposite character. One must be positive and the other negative. Such opposing qualities are illustrated, for instance, by roughness and smoothness, dryness and viscosity, etc. Two homogeneous particles, both positive or both negative, cannot unite if these qualities be of equal magnitude. But attraction between two such similar particles may occur leading to a combination or linking between them if the magnitude or strength of the quality characterising the one is twice or greater than twice as that of the other. All changes in the qualities of the atom and the physical properties of the aggregate depend on this linking. The Jaina view thus seems to bear a family resemblance to the *dualistic hypothesis* of chemical combination propounded by the great Swedish chemist Berzelius nearly after 1800 years.

Regarding the dates of the philosophical systems nothing definite is known. But in the opinion of the most competent authorities on the subject like Max Muller, Macdonell and others it may be stated, without the risk of any serious or adverse criticism, that the six systems of Hindu philosophy gradually took their shape from the time of Buddha (5th century B.C.) to about 100 B.C., accompanied by the growth and expansion of Jainism and Buddhism. At the same time it cannot, however, be denied that they are genetically related to the doctrines preached in the Upanishads and Brahmanas of earlier ages.

We may, therefore, reasonably conclude that the theories relating to the constitution and properties of matter as elaborated in the Hindu philosophies had an independent origin of their own, and were not, as suggested by some European writers, borrowed from the Greeks. In fact, Professor Macdonell in his 'History of Sanskrit Literature' remarks on this question of priority as follows :

"According to Greek tradition, Thales, Empedocles, Anaxagoras, Democritus, and others undertook journeys to

oriental countries in order to study philosophy. Hence, there is at least the historical possibility of the Greeks having been influenced by the Indian thought through Persia "

Colebrooke too sums up his views in the following words

"I should be disposed to conclude that the Indians were in this instance teachers than learners" (*Trans Roy. Asiatic Soc.*, Vol. I, p 579)

Prof. H H. Wilson in his preface to Samkhyakarika (1887, p. IX) also observes .—"that the Hindus derived any of their philosophical ideas from the Greeks seems very improbable, and if there is any borrowing in the case, the latter were most probably indebted to the former."

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CHAPTER III

AYURVEDIC PERIOD

Chemistry in Kautilya

Ayurveda means science of life; and it is believed that Atharvaveda, which deals with recipes for prolongation of life, has given birth to it. Hence, by many authorities Ayurveda is regarded as a subsidiary branch of the Atharvan, and, as such, a revealed production like the Vedas themselves. There is little evidence of any notable addition to the knowledge and practice of chemistry since the days of the Atharvaveda to the time of Gautama Buddha. The post-Vedic period of Brahmanas and Upanishads was, however, conspicuous, as already stated, by the development of philosophical doctrines which ultimately culminated in the building up of the six systems of Hindu philosophies. Theories relating to the origin, constitution and structure of matter, as we have seen, were formulated in some of these philosophies. It may, therefore, be stated that the ancient Indians or Hindus made a significant contribution to the work of constructing scientific concepts and methods in the investigation of physical phenomena, which they freely applied to the development of medicine and chemistry. Their position in this respect can in no way be regarded as inferior to that of the Greeks.

In the Atharvaveda, which deals with recipes for longevity and cure of diseases, we find the empirical basis or seeds of alchemy and medicine. These along with other practical arts were increasingly developed in the following ages. For instance, there is a passage in Samyutta-Nikaya (pt. III, p. 152) where Buddha is described to refer incidentally to a number of vegetable substances used by the dyers or painters for preparing dyes and colours. These are :—(*a*) resin (*rajana*), (*b*) lac (*lakha*), (*c*) turmeric (*halidda*), (*d*) indigo (*nili*) and (*e*) maddar (*manjatthi*).

The earliest and most authentic record of informations relating to the knowledge of chemistry, metallurgy and medicine of these early days is found in the Arthashastra (Treatise on Polity) of Kautilya which gives a magnificent account of the political, social, industrial, civil and military organizations of the 4th century B.C. (321-296 B.C.). Kautilya or Chanakya was the well-known prime minister of the Maurya Emperor Chandragupta and is reported to be the Indian Machiavelli.

A very comprehensive account of ores, minerals and metals with their extraction and working, as well as of alloys, is found in the Arthashastra.

A summary of the description of the ores of gold, silver, copper, lead, tin and iron, as found in the Arthashastra, is given here :

Gold Ores :—"These are obtained from plains or slopes of mountains, and are either yellow, or reddish yellow, or as red as copper in colour. They are marked with spots like drop of curd and resplendent as turmeric, yellow myrobolan, petals of a lotus, aquatic plant, the liver or the spleen. These ores are as yellow as ripe turmeric, sulphide of arsenic *(haritala)*, honeycomb and vermilion. They are very heavy. There is a sandy layer within them and they contain globular masses · when roasted they do not split but emit much foam and smoke. (This indicates the presence of organic matter) They are used to form amalgams with copper and silver". That is they are made use of in converting copper or silver into gold This furnishes evidence of the practice of alchemy in Kautilya's time. (82)*

Silver Ores :—"Silver ores have the colour of conch-shell, camphor, alum, butter, a pigeon, turtle-dove, or the neck of a peacock. They are resplendent as opal *(sasyaka)*, agate *(gomedaka)*, cane sugar and granulated sugar. They may have also the colour of the flower of kovidara *(Bauhinia variegata)*,

* Numbers within parenthesis refer to pages of the original Sanskrit text Passages within inverted comas are the translations made by Shamasastry.

of lotus. of patali (*Stereospermum suaveolens*), of kalaya (a kind of *Phaseolus*), of flax. These ores may occur in combination with lead or iron. When roasted they do not split but emit much foam and smoke. The heavier the ores the greater will be the quantity of metal in them." (82)

Copper Ores :—"These are obtained from plains or slopes of mountains. They are heavy, greasy, soft, tawny, green, dark, bluish yellow (*harita*), pale red, or red." (83)

The description seems to refer to copper pyrites (yellow), cuprite (red) and malachite (green).

Lead Ores :—"Lead ores have the colour of kakamechaka (*Solanum indicum*), pigeon, or cow's bile, are marked with white lines and possess smell like raw meat." (83)

Tin Ores —"These are as variegated in colour as saline soil or have the colour of burnt lump of earth." (83)

Iron Ores .—"These are of orange colour, or pale red, or of the colour of the flower of sinduvara (*Vitex trifolia*)." (83)

Dealing with the qualifications of the officer who will be in charge of conducting mining operations and manufacture Kautilya gives the following instructions :

"The superintendent of mines should possess knowledge of the science dealing with copper and other minerals ; he should have experience in the art of distillation and condensation of mercury and of testing gems. Aided by experts in mineralogy and provided with mining labourers and necessary instruments he shall examine mines which, on account of their containing mineral excrement, crucibles, charcoal and ashes, may appear to have been once exploited, or which may be newly discovered on plains or mountain slopes possessing mineral ores, the richness of which can be ascertained by weight, depth of colour, piercing smell and taste."

"The superintendent of metals (*lohadhyakshah*) shall carry on the manufacture of copper, lead, tin, brass (*arakuta*), bronze (*kamsya*), sulphide of arsenic (*haritala*), and also of commodities from them". (84)

Loha is used as a general name for metals.

"The superintendent of mint shall carry on the manufacture of silver coins made up of four parts of copper, eleven parts of silver and one part of any of the metals iron (*tikshna*), tin (*trapu*) or lead (*sisa*)". (84)

"Copper coins shall be made up of four parts of silver, eleven parts of copper and one part of iron (*tikshna*) or any other metal." (84)

Treatment of Ores and Metals

"The impurities of ores, whether superficial or inseparably combined with them, can be got rid of and the metal melted when the ores are treated (chemically) with iron (*tikshna*), alkalies (plant ashes), etc. " (82)

Recipes are also given about the softening of metals, which are rather difficult to account for.

"Metals are rendered soft when they are treated with the ashes of certain plants and cereals, or with the milk of both cow and the sheep Brittle metals are rendered soft when thrice soaked in a mixture made up of honey, sheep's milk, sesamum oil, clarified butter, jaggery, ferment (*kinva*) and mushroom." (83)

A rather detailed description of the properties of gold and silver, and of their working has been given by Kautilya.

"Gold may be obtained either pure or amalgamated with mercury or silver, or alloyed with other impurities as mine gold." (85)

"That which is of the colour of the petals of lotus, ductile, glossy, incapable of making any continuous sound, and glittering, is the best. That which is reddish yellow is of middle quality; and that which is red is of low quality" (85)

"Impure gold is of whitish colour. It shall be fused with lead four times the quantity of the impurity When gold is rendered brittle owing to its contamination with lead, it

shall be heated with dry cow-dung, when it splits into pieces owing to hardness. It shall be drenched (after heating) into oil mixed with cow-dung." (86)

"Mine gold, which is brittle owing to its contamination wit lead, shall be heated wrapped with cloth and hammered on a wooden anvil. Or, it may be drenched in a mixture of mushroom and vajrakhand (*Euphorbia antiquorum*)." (86)

"Silver, which is white, ductile and glossy, is the best; and that which is of the reverse quality is bad." (86)

"Impure silver should be heated with lead of one-fourth the quantity of the impurity.

That which becomes full of globules, white, glowing and of the colour of curd is pure." (86)

This indicates that the knowledge of the purification of gold and silver by alloying with lead was known in Kautilya's time. This is comparable to the modern process of cupellation.

"When from one to sixteen *kakanis* of gold in a pure specimen of the metal (of sixteen *mashakas*) are replaced by from one to sixteen *kakanis* of copper so that the copper is inseparably alloyed with the whole mass of the remaining quantity of the gold, the sixteen varieties of the standard of the purity of gold will be obtained." (86)

This may be compared to the modern system of expressing the standard of purity of gold by *carat* numbers. Description is also given for testing the purity of gold by means of touchstone.

Working of Gold and Silver

"Three kinds of ornamental work with gold have been described by Kautilya. These are named *kshepana*, *guna* and *kshudra*."

"By *kshepana* is meant the setting of jewels or glass beads (*kacha*) in gold."

"The process by which threads or wires are drawn from the metal is termed *guna*."

"Solid and hollow work, and the manufacture of beads with a rounded orifice is termed *kshudra* (literally low or ordinary work)." (87)

The mention of *kacha* (glass) here indicates that the knowledge of making glass was known in Kautilya's time.

"For setting jewels in gold, five parts of pure gold and two parts of gold alloyed with four parts of copper or silver shall be the required quantity." (88)

"For silver articles, either solid or hollow, silver may be mixed with half of the amount of gold." (88)

"Pure gold combined with an equal quantity of lead and heated with rock salt to the melting point under dry cow-dung becomes the basis of gold alloys of blue, red, white, yellow, parrot and pigeon colours." (88)

"The colouring ingredient of gold is one *kakani* of *tiksh.na*, which is of the colour of the neck of peacock, tinged with white, and which is dazzling and full of copper." (88)

Tikshna here obviously refers to copper sulphate partially dehydrated. The resulting product is a gold-copper alloy.

"Pure or impure silver may be heated four times with copper sulphate mixed with powdered bone (*asthituttha*), again four times with an equal quantity of lead, again four times with dry copper sulphate (*sushkatuttha*), again three times in skull and lastly twice in cow-dung." (88)

Heating silver with lead in skull, which consists mainly of calcium phosphate, practically resembles the cupellation process for the purification of silver.

Kautilya describes further the preparation of a large variety of gold alloys with different quantities of copper and silver. The process of assaying has also been mentioned and stressed upon.

Pure gold has been defined as follows.

"Uniform in colour, equal in the colour of its test streak to that of the standard gold, devoid of air holes, ductile, very smooth, free from alloying elements, pleasing when worn as an ornament, glittering but not dazzling, and pleasing to the mind and eyes." (89)

Various types of working for the manufacture of gold and silver articles are defined as :

"Compact work (*ghana*), compact and hollow work (*ghana-sushira*), soldering (*samyuhya*) amalgamation (*avalepya*), enclosing (*samghatya*), and gilding (*vasitakam*)." (90)

A description of false balances for the weighing of gold is also given in the Arthashastra.

"According to this, balances may be made to give false weights by bending of the arms ; by the provision of a high helm or pivot ; by means of a broken head or of a hollow neck ; by use of lead strings, bad cups or pans ; by making them crooked or shaky ; or by fixing a magnet in the body." (90)

Kautilya further gives a graphic account of the methods employed by the goldsmiths for the adulteration and stealing of gold by substituting baser metals for it.

"Folding either firm or loose is practised in soldering, in preparing amalgams, and in enclosing (a piece of base metal with two pieces of a superior metal)." (91)

"When a lead piece is firmly covered over with gold-leaf by means of wax, the process is termed as firm folding." (91)

"In amalgams a single or double layer of a superior metal is made to cover a piece of a base metal. Copper or silver may also be placed between two leaves of a superior metal. A copper piece may be covered over with a gold-leaf, the surfaces and edges being smoothed ; similarly a piece of any base metal may be covered over with double leaf of copper or silver, the surfaces and the edges being smothered." (91)

In a chapter on the examination of gems that are to be admitted into the treasury we find in Kautilya a description of

the several varieties of pearls and other gems viz, diamond, coral, sapphire, ruby, emerald, opal, etc. The methods for examining the quality of these precious stones have also been given. (75, 76, 77)

At another place we find that "the superintendent of ocean-mines shall attend to the collection of conch-shells, diamonds, precious stones, pearls, corals, and salt (*kshara*), and also regulate the commerce in the above commodities" (84)

Various types of salts have been distinguished by Kautilya ; viz. *saindhava*, derived from the country of Sindhu, *samudra*, produced from sea-water ; *bida* ; *yavakshara*, literally ashes of barley (potash), but often employed for nitre : *sauvarchala*, derived from the country of Suvarchala ; *udbhedaja*, that which is extracted from the saline soil (94)

Kautilya gives instances of acids in liquid form, e.g curds, acids prepared from grains and the like (evidently by fermentation). (95)

Extraction of oils from linseed, seeds of nimba (*Azadirachta indica*), sesamum, ingudi (*Balanites roxburghii*), etc. has been mentioned. (96)

Kautilya states further that charcoal and chaff obtained as waste products in the preparation of many food materials may be given over for iron-smelting and lime-kiln (*bhittilepya*). (97)

Fermented Liquors

In a chapter defining the duties of the superintendent of liquor Kautilya writes :

"By employing such men as are acquainted with the manufacture of liquor and ferments (*kinva*), the superintendent of liquor shall carry on liquor traffic not only in forts and country part (shops), but also in camps." (119)

Various kinds of liquors described are .

Medaka, *prasanna*, *asava*, *arista*, *maireya*, and *madhu*. (120)

Medaka is prepared from the fermentation of rice; *prasanna* from the fermentation of flour with the addition of spices and the fruits of *putraka* (a species of tree in the country of Kamrupa). *Asava* is the liquor derived from the fermentation of sugar mixed with honey Jaggery mixed with powder of long and black pepper or with the powder of *triphala* (mixture of *Terminalia chebula*, *Terminalia belerica*, and *Phyllanthus emblica*), when fermented, forms *maireya*. Fermented grape juice is termed *madhu*. The preparation of different kinds of *arista* for different diseases can be learnt from the physicians.

Kinva or ferment is prepared from boiled or unboiled paste of *masha* (*Phaseolus radiatus*), rice and morata (*Alangium salvifolium*) and the like.

"The liquor that is manufactured from mango fruits may contain a greater proportion of mango essence or of spices. It is called *mahasura* when it contains *sambhara* (spices)" (121)

It is interesting to note that Kautilya writes that all varieties of liquor other than that used for the king are taxable with 5 per cent as toll. These include acid drinks prepared from fruits (*phalamla*) and spirit distilled from molasses (*amla sidhu*) But on the occasion of festivals, fairs (*samaja*) and pilgrimage it is permissible to manufacture liquor for four days (*chaturahassaurikah*)—liberty to drink liquor without limit).

(121)

From a survey of the informations contained in the Arthashastra, so far as it concerns us, we find that there was a considerable advancement in the knowledge of metals and their working Methods for the large scale production of metals like gold, silver, copper, iron, tin, lead and mercury and of alloys like brass, bronze, and those of gold and silver with baser metals were known. Large varieties of minerals, ores, gems and precious stones have been described in detail in his treatise by Kautilya. Knowledge of the fermentation process reached also a fairly advanced character. The description of silver, tin and mercury ores, which are till now not known to occur in India, seems to suggest their importation from neighbouring

countries. Sulphide of mercury *hingula* was possibly obtained from China, tinstone from Malava and Persia, and silver ores from Afghanistan and Persia. It should be noted that Kautilya has prescribed severe penalties for goldsmiths who would fraudulently adulterate gold articles or gold coins with baser metals, or try to pass baser metals as gold by folding or amalgamating them with gold-leaves. This indicates that alchemy received little favour or credence in Kautilya's time.

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CHAPTER IV

AYURVEDIC PERIOD

Chemistry in the Charaka and the Susruta

We now come to a time when the Hindu system of medicine was methodised and arranged more or less on a rational basis, with a scientific terminology. The two earliest and most renowned treatises of the period are the Charaka and the Susruta, by sages of the same names, dealing respectively with medicine and surgery in the main. They constitute the repositories of many chemical informations of the time. These treatises, usually known as the Charaka Samhita and the Susruta Samhita, passed through repeated recensions by later and more advanced workers.

There is much controversy about the age of the Charaka and the Susruta. According to the Chinese version of the Tripitaka a physician named Charaka was attached to the court of the Indo-Scythian King Kanishka who reigned in the second century A.D. According to certain authorities, particularly M. Sylvain Levi, the authorship of the treatise Charaka Samhita is attributed to this Charaka. But it should also be noted that the appellation of Charaka occurs in Vedic literature as a patronymic one. The theories and discussions in the Charaka and the Susruta, particularly in the Charaka, are based on the doctrines of the Samkhya system of philosophy, combined with a methodology derived from the Nyaya-Vaiseshika system. The Charaka, however, is not so systematic as the Susruta, but indulges often in random and irrelevant discourses. In the Charaka Samhita we find that the author is inordinately fond of metaphysical disquisitions in preference to experiments and observations. The Susruta in this respect is far more scientific than the Charaka. This indicates that of the two, the Charaka is by far the more ancient. Again we find only Vedic gods and *mantras* to figure in the Charaka which follows closely the

authority of the Vedas. The simple unvarnished prose of the Charaka reminds one of the Brahmanas of the Vedas Between the period of the Atharvaveda and that of the Charaka there must have been composed several medical treatises, each reflecting the spirit and progress of the age. Charaka himself records that he simply based his work on that of Agnivesa, which he completely recast and remodelled. At the time of Charaka there existed at least six standard works by Agnivesa, Bhela Jatukarna, Parasara, Harita and Ksharapani respectively Thus the Charaka, as we now possess it, is by no means the first comprehensive and systematic treatise of Hindu medicine: it represents rather a fairly developed state of the subject. There are chapters in the Charaka Samhita which suggest that it seems to record the deliberations of a congress of medical experts. This is best illustrated by the chapter in the Charaka on "Discourse on the Tastes."

The compilatory character of the Charaka is more or less evident from its chapters which often overlap in their content It appears to have gathered, sifted and brought into a definite form the informations handed down from the preceding ages

Agnivesa, whose work formed the basis of the Charaka Samhita, was the disciple of Atreya who, according to a Buddhist Jataka, was a teacher of medicine in the University of Takshasila (Taxila) during the age of Buddha.

From the considerations set forth above, it might be concluded that there should be little hesitation in placing the original work of Charaka in the early Buddhistic era though P. C. Ray in his History of Hindu Chemistry prefers to place it in the pre-Buddhistic era. Moreover, the chemical informations recorded in the Charaka, particularly with reference to metals and metallic preparations, are of less advanced character than those in the Arthashastra of Kautilya, which, as we have seen, was composed sometime between 321—296 B C.

The extant Charaka is a redaction by Dridhavala of the genuine Charaka Samhita.

As regards the age of the Susruta, the evidences are, however, comparatively definite. Its terminology and technique in general, do not differ much from those of the Charaka. Its style is rather dry, laconic and matter-of-fact, in contrast to the discursive and diffusive character of that of the Charaka. It aims at some systematic classification of a large amount of matter avoiding unnecessary details. This indicates a somewhat later date of its composition. The extant Susruta is generally believed to be a comparatively modern recension by the celebrated Buddhist chemist, Nagarjuna (8th century A.D) who is said to have added the Uttaratantra or the Supplement. There is evidence that the redactor thoroughly recast and remodelled the original work of Susruta ; for there are numerous passages in it, which agree almost *verbatim* with those found in the Charaka The Susruta is *par excellence* a treatise on surgery as the Charaka is on medicine proper. Susruta is said to be the disciple of Dhanvantvari In the Charaka we find a distinction drawn between "Kaya-Chikitsakas" i.e. the physicians properly so-called, and the "Dhanvantvari Sampradayas" i.e. followers of Dhanvantvari or the chirurgeons. According to a Buddhist Jataka, Susruta was a teacher in the University of Kasi (Banaras) during Buddha's time and was a younger contemporary of Atreya. Hence, though the original Susruta was composed somewhat later than the Charaka, there cannot be a great interval between the two. It should also be borne in mind that the extant Charaka and Susruta represent not only the chemical and therapeutical knowledge of the time of their final redaction, but they are also repositories of informations, accumulated on the subject, during the earlier periods dating back to the Vedic Age.

The Charaka

Charaka mentions of six metals and their calces for use as drugs. These are : gold, silver, copper, lead, tin and iron.

According to Charaka all objects are the results of the combination of five elements, viz., earth, water, fire, air and ether or space.

Five kinds of salts are described in the Charaka. Thees are *sauvarchala* (nitre), *saindhava* (rock salt), *vit* (black salt), *audbhida* (vegetable salt) and *samudra* (sea salt).

Minerals like sulphate of copper, sulphate of iron, realgar, orpiment and sulphur have been prescribed in combination with vegetable drugs for use as external application in many skin diseases.

Preparation of alkali *(kshara)* has also been described in the Charaka as follows:

"A young *Butea frondosa* is to be cut to pieces, dried and finally reduced to ashes. The ash is lixiviated with four or six times its weight of water and strained twenty-one times through linen."

This obviously gives rise to a solution of potash carbonate.

Rust of iron and pyrites have also been prescribed for use as constituents of pills.

Ashes of conch-shell, coral, lapis lazuli, calces of iron and copper, and sulphide of antimony have been described as ingredients of collyrium.

Under the recipe of a pearl compound, there is mention of pearl, powder of iron, copper and sulphur. The metals are obviously used after being roasted with sulphur. The process is described as the *killing of metals.*

A process has been described for treating thin sheets of iron, silver and gold with hot solutions of salts and alkali (potash carbonate) for use as drugs.

In the Charaka Samhita mention has been made of the nine sources of spirituous liquor or fermented drinks. These are: cereals, fruits, roots, wood, flowers, stems (stalks), leaves, barks of plants and sugar from various sugar-yielding canes. From these, the preparation of 84 different kinds of *asava* (wine) has been described. The nine main classes of liquors from the

nine sources, mentioned above, are named respectively as :— *Dhanyasava, phalasava, mulasava, sarasava, pushpasava, patrasava, kandasava, tvagasava*, and *sarkarasava*.

According to Charaka medicines are classified under two main heads : one increases the strength and vitality of people, already healthy (*vital elixir*), the other cures diseases (cf. *ayushyani* and *bhaishajyani* of Atharvaveda). The former, which promotes longevity, retentive memory, health, vitality, etc., is called *Rasayana*, and may, therefore, be regarded as a part of alchemy.

Dealing with the preparation and use of alkalies and alkaline caustics Susruta makes the following remarkable observations :

"Of all cutting instruments and accessory cutting instruments, caustics are superior in as much as they perform the work of incisions, punctures and scarifications, relieve derangement of three humours and uniformly affect the diseased part to which they are applied. *Kshara* (caustics) are so called because they remove diseased parts and destroy the skin and flesh. They possess burning escharotic and lacerating properties. Caustics are acrid, hot and pungent.

"Alkalies are of two sorts, namely, for external application and internal administration.

"They are made of three different strengths (in solution), namely weak, moderate and strong."

Susruta describes the preparation of these three varieties of alkali.

"With due religious ceremonies some trees or plants are cut to pieces on an auspicious day in autumn by the worker. These pieces are piled in a place free from wind. Some limestone should be placed on the pile and then set on fire by stalks of a selected plant. When the fire is extinguished, the ashes of the tree and the burnt lime should be kept separate.

"Thirty-two seers of ashes should be stirred or mixed with six times their quantity of water and the mixture strained

through cloth. This should be repeated twenty-one times. The strained fluid should then be boiled slowly in a large pan and agitated with a ladle. When the fluid becomes clear, pungent and soapy to the feel, it should be removed from the fire and strained through cloth. The dregs being thrown away, the strained fluid should be again boiled. From this alkaline solution take three quarters of a seer.

"Then take eight palas each of burnt limestone, conch-shells and bivalve shells, and heat them in an iron pan till they are of the colour of fire. Then moisten them in the same vessel with the above-mentioned three quarters of a seer of alkaline water and reduce them to powder. This powder should be thrown on sixty-four seers of the alkaline water and boiled with constant and careful agitation by the ladle. Care should be taken that the solution is neither too thick nor thin.

"When reduced to proper consistence, the solution should be removed from the fire and poured into an open jar. The opening or mouth of the jar should be covered and should be kept in a secluded place. This preparation is called *madhyama kshara* or alkaline caustic of middling strength.

"When the alkaline water is simply boiled to the proper consistence without the addition of burnt shells, etc., the preparation is called *mridu kshara* or mild alkaline solution.

"The strong alkaline caustic, i.e., *tikshna kshara* is prepared by boiling the weak solution with some dried plants in the form of powder."

Obviously *tikshna kshara* represents concentrated caustic alkali solutions

Dealing with the properties of alkali Susruta writes :—

"Good alkaline caustics should be neither too strong nor too weak. They should be white in colour, smooth and soapy to the touch, should not spread beyond where they are applied, and act rapidly and successfully. These are the eight good properties of the caustics. Their bad qualities consist in their being too weak or cool, too strong or hot, too slippery and

spreading, too thick or too underboiled, or they may be deficient in ingredients."

Neutralization of the alkali by an acid has also been described by Susruta.

"If you question, my son! how is it that the application of the pungent acid of *kanjika* (fermented rice water, i.e. crude vinegar) relieves the burning of the fire-like hot alkaline caustic, then hear the following explanation from me. Alkalies possess all the tastes except that of the acid. The acrid taste prevails in it and the saline one to a less degree. The sharp saline taste when mixed with acid becomes very mild, and gives up its sharp quality. From this modification of the saline taste, the pain of caustics is relieved just as fire is extinguished by water."

From the description given above about the preparation of alkalies, it will be noticed that there is a distinct mention of 'mild' and 'caustic' alkalies in the body of the text. The process of lixiviating the ashes and rendering the lye caustic by the addition of lime leaves very little to improve upon and appears almost scientific.

Distinction has also been made between the alkalies, *yavakshara* (factitious carbonate of potash) and *sarjikakshara* (trona or natron). Borax too has been mentioned under alkali.

Susruta has dealt mostly with vegetable drugs. There is, however, one sloka in which the six metals, viz, tin, lead, copper, silver, krishna loha (iron) and gold, and their calces are also recommended for use as drugs. Among the minerals Susruta has made use of sulphate of copper, sulphate of iron, alum-earth, red ochre, realgar, etc., as medicaments for external application.

Roasting of iron and other metals has been described, which is considered necessary to make them fit for internal administration.

For the roasting of iron thin leaves of the metal are to be smeared with the levigated powder of the salts including

common salt, saltpetre and sulphate of magnesia, and heated in the fire of cow-dung cakes. The process is to be repeated sixteen times. The method is equally applicable to the other metals. The metals are no doubt converted hereby into their respective oxides, or oxychlorides as the case may be. Susruta thus describes a practical method, though crude and imperfect, for the preparation of metallic salts. The process has been given the general name, *ayaskriti*, which means action affecting the metals. The much reputed 'potable gold' in the shape of the the chloride of the metal was probably obtained in this manner. Two types of iron pyrites with the lustre of gold and silver have been described in the Susruta, denoting obviously those containing copper and those free from copper respectively.

Compounds of arsenic such as white arsenic (*phenasma bhasma*) and orpiment were recognized as poisons

There occur one or two references to mercury, though somewhat vague. It seems mercury was not well known in Susruta's time.

Like Charaka, Susruta has also described a large variety of liquors prepared from the juice of fruits like grapes and raisins, from date-palm juices, from rice-paste and barley, from sugarcane juices, treacle and honey, as well as from flowers and bark of trees

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CHAPTER V

AYURVEDIC PERIOD

Chemistry in the Bower Manuscript

The Bower manuscript is possibly the oldest existing medical manuscript. *It was discovered by the British Lieutenant*, A. Bower, in 1890 in a Buddhist monument at Kutcha in the Chinese Turkestan. Palaeographic evidence indicates its origin in the second half of the fourth century A D The contents should, therefore, represent knowledge acquired some centuries earlier than is warranted by the palaeographic evidence about the date of the manuscript. It consists of a series of medical and pharmaceutical monographs (*kalpa*) and treatise (*tantra*) Many of the chapters may be regarded practically as revision of similar ones found in the Charaka But no reference to the Charaka is found anywhere in the Sanskrit text of the manuscript, though the Susruta is explicitly quoted. It thus helps us in determining the chronology of the Charaka and the Susruta.

Yavakshara and *sarjikakshara* are the two alkalies mentioned in the manuscript. These obviously represent the two carbonates of potash and soda respectively

As a remedy for hiccough the fumes of horn have been recommended. This is practically the same as "spirits of hartshorn" or ammonia

Preparation of alkali (potash carbonate) by burning vegetable matter has been described for use in 'Ksharataila' recommended as a remedy for diseases of the ear. (Part II. fasc. ii, p. 131).

Mention of sulphates of copper and iron *boiled with* the oil of beleric myrobalans has been made as a remedy for turning grey hair into black in a formula for hair-dye (Pt. II, fasc ii, p. 162).

Srotaja anjana, riparian sulphides of antimony, red ochre, galena, realgar, calx of brass, etc. have also been mentioned for use in medicines (*ibid*, p. 131.).

Recipes of several important preparations, described in the Bower manuscript, agree in all essentials, and sometimes word for word, with those of the Charaka and the Susruta of the existing recensions.

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CHAPTER VI

AYURVEDIC PERIOD

Chemistry in the Vagbhata.

The treatise of medicine, next in importance to the Charaka Samhita and the Susruta Samhita, in which we can find some chemical informations worthy of note, is Astangahridaya (*lit.* heart or the kernel of the eight limbs or divisions of medicine), due to Vagbhata. As a medical authority Vagbhata was held in high estimation throughout India next to Charaka and Susruta. Vagbhata was Buddhist by religion, as the opening salutation of his treatise, addressed to Buddha or some Buddhistic emblem, clearly reveals. He most probably flourished during the ninth century A.D. (c. 800-850 A.D.).

Some authors place Vagbhata in the seventh century A.D., but evidences recently gathered on the subject by D. C. Bhattacharyya definitely support the later date.

Vagbhata is regarded as unrivalled in the principles of medicine (*sutra*). But his treatise may, however, be represented as an epitome of the Charaka and the Susruta with some gleanings from the works of Bhela and Harita. He introduces certain modifications and additions to surgery described in the Susruta. Mineral and natural salts chiefly figure in the prescriptions along with vegetable drugs; mercury is incidentally mentioned, but in such a perfunctory manner as to exclude any assumption about the knowledge of its compounds. Some metallic preparations are, however, recommended in it, which would presuppose an advanced knowledge of chemical processes.

In a recipe for medicine recommended as an external application for sores the names of the following minerals are found to occur. sulphate of copper, red ochre, realgar, orpiment, sulphate of iron, etc.

Many preparations of gold, silver, copper, iron, tin and lead have been described.

In one case direction has been given to roast in a closed crucible (*andhamusha*) a mixture of 64 parts of stibium (*srotonjana*) and one part each of copper, iron, silver, and gold (*Uttarasthanam*, Ch, XIII, p. 20-21).

In another preparation there is a direction for roasting in a closed crucible a mixture of 30 parts of lead, 5 parts of sulphur, 2 parts of copper and orpiment each, 1 part of tin and 3 parts of stibium. (*ibid*, p. 31-32).

Vagbhata borrows his method of preparation of alkali almost word for word from the Susruta. The process of rendering mild alkali caustic by the addition of lime has been described in detail as in the Susruta. (*Sutra*, Chap. XXX).

The only instance in which the mention of mercury occurs is in a recipe given as follows:

Take equal parts of mercury and lead and make them up into a collyrium with their equal weight of stibium and camphor. (*Uttarasthanam*, Chap. XXX, p. 36).

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CHAPTER VII

AYURVEDIC PERIOD

Chemistry in Practical Arts.

In this chapter we proceed to deal with the knowledge of chemistry as involved in various practical arts developed by the ancient Indians during the Ayurvedic Period. These include making of glass and pottery, metallurgy and metal working, dyes, paints and colours, perfumes, cements, etc.

Glass and Pottery

Glass. It has been stated before that Kautilya has made mention of glass (*kacha*) beads in connection with some ornamental work with gold (*kshepana*) The Indians of Kautilya's time were, therefore, acquainted with the process of glass-making. Glass (*kacha*) was differentiated from crystal (*sphatika*) as early as in the days of Susruta (Chap. 46). Pliny also referred to the glass of India as superior to all others (Pliny, 36, 66). He further states (37, 20) that "the people of India by colouring crystals have found a method of imitating various precious stones, beryls in particular". Even in certain literary and poetical works of early India, as also in the great epic, Mahabharata, mention of glass is known to occur at many places. In the drama Vasavadatta (6th century A.D) mention has been made of glass coloured like the neck of peacock. That the art was of still earlier origin in ancient India has now been proved by the recent discovery of the site of an ancient glass factory, believed to be of about fifth century B.C., at Kopia on the bank of river Anoma near Khalilabad in the Basti district of terai region of the Uttar Pradesha. Excavations of the remains of a Buddhistic stupa near the village of Piprahwa in the same district, not far from Kopia, by Mr Peppe in 1897-98 led to the recovery of a steatite casket from the bed of this stupa. The casket was found to contain the relics of Buddha (bones

and ashes) together with some small glass beads, pearls, gold and silver leaves, jewelleries, etc. The surface of the casket has an epigraph in Pali language written in Brahmi script. The glass beads found at Kopia bear a striking resemblance to those contained in the Piprahwa casket, in their texture, material, shape, size and execution. As the inscription on the casket indicates its origin sometime in the fifth century B.C., it might be reasonably assumed that the Kopia beads and those of the Piprahwa casket are the products of the same age and the same place.

M. M. Nagar, who visited the the locality at Kopia in 1949 found countless number of tiny glass beads and glass pieces of various shapes and sizes, scattered all over the place. Fragments of earthen crucibles with glass sticking to the inner side were collected by him. Lumps of glass in various stages of formation and of various colours were noticed. These give some idea of the process adopted for melting, refining and colouring the glass. A block of glass discovered by him was found to weigh about 120 lb. and to have a dimension of 18" x 19" x 12". The block was found to contain some over-burnt brick-bats, used possibly for reinforcement (Figs. 15. *a, b, c, d.* and 16).

The most striking among the finds are the tiny glass beads perforated with extremely fine holes, difficultly visible to the naked eye. They are brilliantly coloured and highly polished.

Chemical analyses of some of the Kopia glasses were made by P. Roy of the Central Glass and Ceramic Research Institute, Calcutta. The results are quoted in the Table IV.

The specific gravity of many of these pieces (perforated beads and bangles) was found by the same analyst to vary between 2.33 to 2.68. One characteristic feature of all these pieces is that they are soda-lime glasses containing a high percentage of alumina.

The use of glass bangles in India was possibly introduced sometime about the 8th-9th century A.D. by foreign tribes like the Huns and Gurjaras coming from Central Asia. Sir Aurel

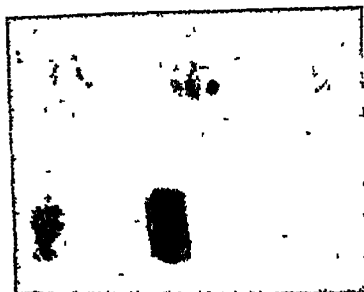


Fig. 15*a*. Glass pieces of different colours (Kopia).

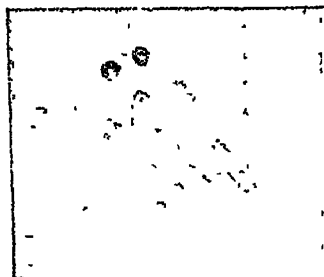


Fig. 15*c*.
Fine perforated coloured beads and glasses (Kopia).



Fig. 15*b*. Miscellaneous specimens of beads (Kopia).



Fig. 15*d*. Miscellaneous specimens of beads (Kopia).



Fig. 16.
Refractory clay pieces (Kopia).

Fig 15 (a to d) and Fig 16—Through the courtesy of the Director, Central Glass and Ceramic Research Institute

TABLE IV

(KOPIA GLASSES)*

Sample	Silica SiO_2	Alumina Al_2O_3	Ferric oxide Fe_2O_3	Titania TiO_2	Lime CaO	Magnesia MgO	Alaklies Na_2O	Manganese oxide MnO	Total
1.	62.24	8 48	7 20	0 51	3.13	1.55	16.70	0 20	100.01
2.	70.30	5 30	1 20	traces	2 38	1.20	19.51	0.08	99 97
3.	64.80	7.35	0.95	0 45	3 71	2.10	20 59	0.06	100 01
4.	67.18	7.00	1.50	0.40	3 10	1.60	19 15	0.07	100·0
5.	66.13	7 26	0 86	0.41	2.24	1.33	21.67	0.10	100.0
6	63.30	7.09	2.50	1 01	3 64	1 85	20.50	0.03	99.92
7.	66.60	6.98	1 62	trace	2.40	trace	21 70	0 07	99.37
8	60.72	10 84	0 20	—	8.85	1.12	18.30	—	100.03

* Through the courtesy of Dr. Atmaram, Director, Central Glass and Ceramic Research Institute, Calcutta.

Stein found some specimens of glass bangles, slightly tinted in various shades of pale green and straw colour, and often ornamented with applied rib-work or cutting.

Glass beads (0.2"-0.3" dia.) have also been found at Bangarh in the Dinajpore district of Bengal, which may be ascribed as dating from the Mauryan to the Kushan period (i.e. 3rd century B.C. to the 2nd century A.D.). Glass beads and bangles have also been found at Taxila (*vide infra*)

Coins and Terracotta at Kopia

A large number of coins and terracotta have also been found at Kopia. The coins were mostly inscribed and they range in date from the third century B C. to the third century A D., representing the Punch-marked, Panchal, Ayodhya, Kosam and Kushan series. The terracottas too belong to the same age. They are mostly modelled, but few were found to be moulded. They are statuettes of human figures

Pottery

A number of sites in Northern and North-Central India have produced potteries which belong to the period ranging from the 5th to the 1st century B.C. The wares are of a distinctly highly polished type. Their quality seems to suggest a common cultural origin, and a limited duration. The body consists of a finely levigated clay, usually grey but sometimes reddish in sections This is covered with a brilliantly burnished slip having the quality of a glaze, ranging in colour from jet-black to grey, metallic steel-blue, occasionally varied with reddish brown patches. The wares are readily distinguishable by their brilliance from other polished or graphite-black wares which occur also in South India. The usual forms of the wares are dish and bowls. They have been found in relatively large numbers at 18 different sites, e g. Ahichchhatra, Mathura, Kausambi, Bhita, Sarnath, Rajghat, Jhusi, Masaon, Astranji-kheda in the Uttara Pradesha ; Patna, Girak, Rajgir, Buxar in Bihar ; Sanchi in Bhopal ; Taxila in the Punjab ; Bairat in

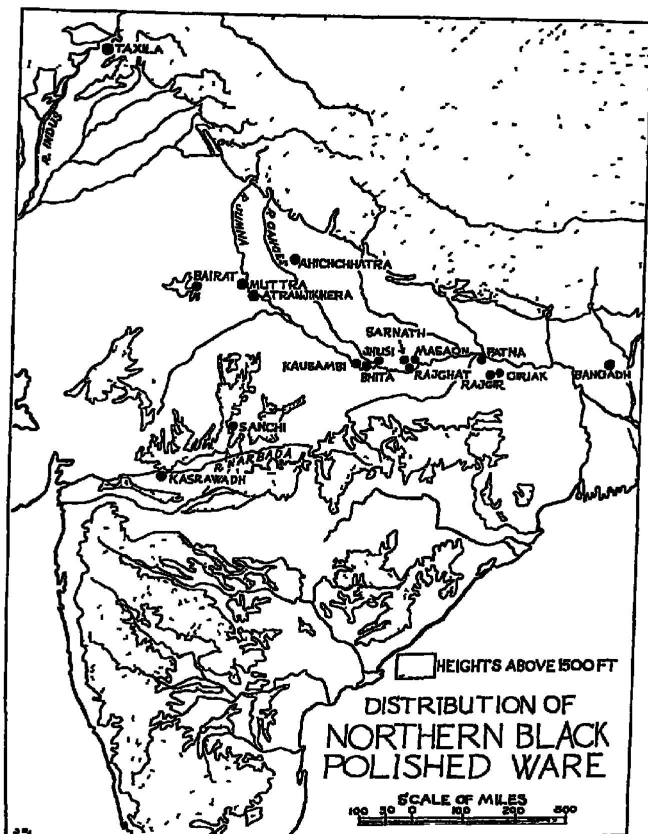


Fig 17. (*Ancient India*, 1946).

the Jaipur State ; Kasrawadh in the Indore State ; and at Bangrah in the Dinajpore district of Bengal. These sites are shown in the map (Fig. 17).

M. Sanaullah, the archæological chemist gives an account of their composition and of the process involved in their making on the basis of his analysis The black colour is attributed by him to the presence of ferrous oxide (about 13 per cent). The original slip was evidently a highly ferruginous body consisting possibly of a finely levigated mixture of clay and red ochre. This was ground in water and applied to the surface of the vessel before firing. The black colour was developed by the action of reducing gases formed in the kiln The polishing might have been done before or after the firing. The coating is not a siliceous glaze

The black polished film has been analysed with the following results :

> SiO_2, 46.55 ; FeO, 25.20 ; Al_2O_3, 15 53 ; CaO, 4.74 ;
> MgO, 3 43 ; alkalies not determined ; H_2O (110°C),
> 3.45 per cent. (Sanaullah).

The black colour is evidently due to the formation of ferrous silicate. There is no evidence that it is due to carbon as has been suggested by some.

According to Sanaullah the presence of lime and magnesia increased the fusibility of the silicate layer of the surface, rendering the latter highly polished and hard. That carbon particles are also deposited in the pores of the wares during burning in a smoky atmosphere, when some tarry matter is condensed on the surface, has been confirmed by him.

Excavations at Sanchi, Taxila and other places have revealed further informations regarding the character of potteries in India during this period (Mauryan period)

The polished stone surfaces of many of the Sanchi sculptures are reddened with a translucent stain, which has the advantage of not obscuring the texture of the stone or the delicate details of the carving. At a later date, gateways and

railings were covered with a coat of creamy lime followed by a thin red wash, which gave the stone a dull dead appearance. Paintings on walls have been found to be made by mixing red ochre with lime-wash to give red or *geruka* (brownish yellow) colour. Red lead or minium has also been found as an ingredient for the application of red paint.

At Taxila many pottery specimens of the early age have recently been unearthed. They furnish some ideas about the types of pottery prevalent during the Saka-Parthian and Kushan period (Fig. 18). The findings here consist of a white paste, glass beads and terracotta objects. Majority of the glass beads are of opaque glass and have colours ranging from dark yellow to orange and copper-red. They are disc-like, cylindrical or circular in shape. Some of the beads are also translucent and are of different colours like white, green, blue, purple, white iridescent, etc. Glass bangles, green or blue in colour, generally opaque and rarely transparent, have also been found. Some of these show a chalky coating from the devitrefication of the glass due to atmosphere and subsoil conditions.

The earliest specimen of true glass in India according to Marshall was found at Taxila in the Bhir mound (circa 5th century B.C.). A few specimens of blown wares in the form of flasks of sea-green or jade-green colour have been found at the Sirkap site belonging to the late Saka-Parthian age (1st century A.D.). It is, however, believed that they are mostly imported from the West, being typical of late Hellenistic and Roman flasks of blown glass (Fig. 18*a*)

The pottery at Taxila (of circa 150-200 A.D.) was highly developed and sophisticated as can be judged from the quality and finish of the wares. They are characterised by the frequent employment of utilitarian devices. such as the pinched lips, handles, spouts, etc. There appears to be a predilection for flat and stable bases. With the exception of large storage jars the entire range of the pottery appears to be wheel-turned and made of well-levigated clay of fine or medium grain. The pots

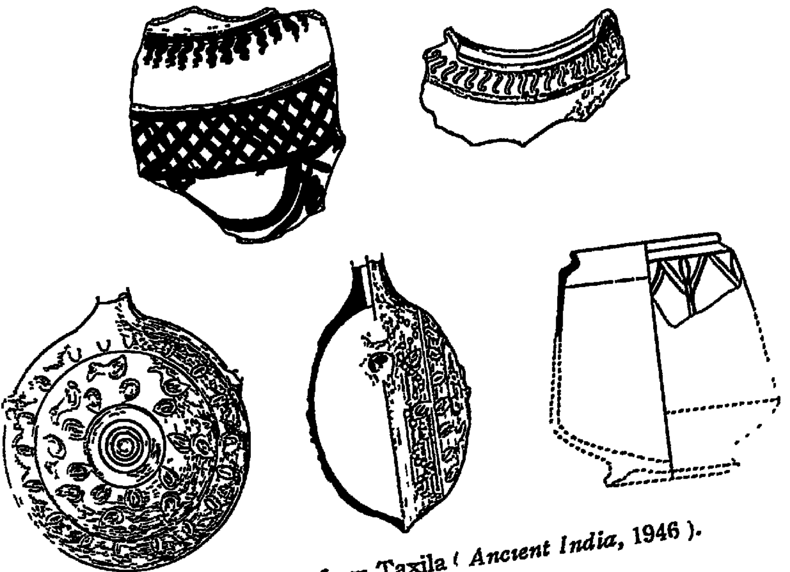


Fig. 18. Potteries from Taxila (*Ancient India*, 1946).

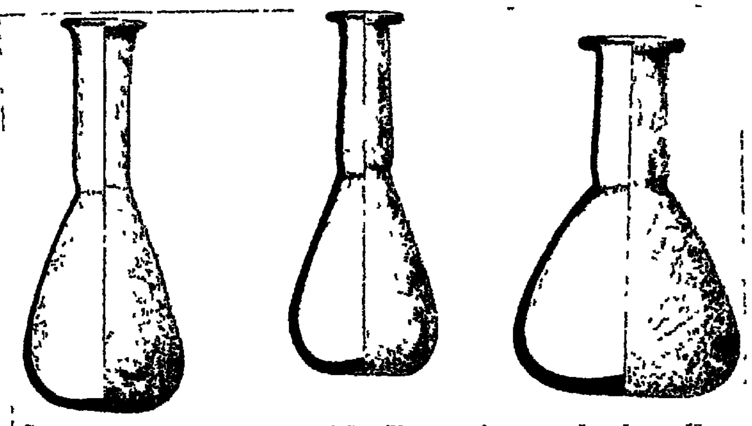


Fig. 18*a*. Glass vessels from Taxila
(Marshall, *Taxila*, Vol. III, 1951).

were fired in oxidizing conditions and burnt from dull red or greyish red to pink or light red in colour.

A large majority of types was treated with a red ochreous slip varying in colour from pink through light red to dark red in shade. Decorated pottery formed a small percentage. The decoration consisted of painted, stamped, and neat impressed patterns. The painted decoration is normally in black on a red-slipped ground. The black colouring agent is believed to be magnetite or black oxide of iron, applied in a finely divided state with a brush before firing. The painted designs comprise triangles, loops, festoons, wavy lines, conventional flowers, cocks or peacocks, etc.

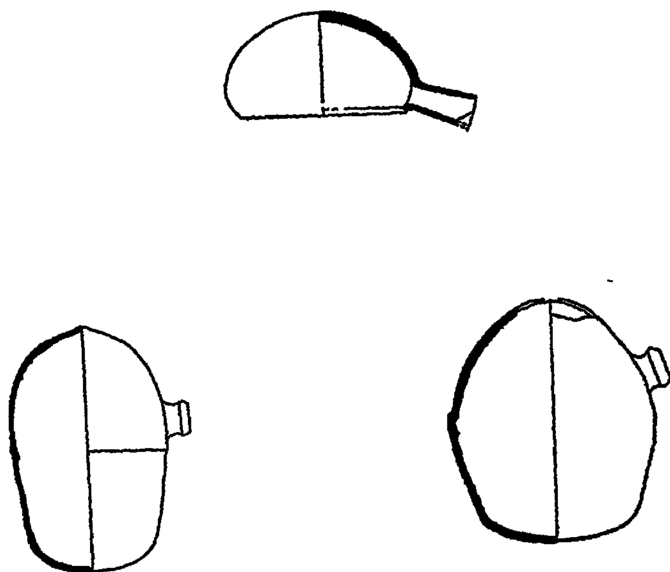


Fig. 18*b*, Potteries from Taxila
(Marshall, *Taxila* Vol. III, 1951 ; Plate 125)

Special reference may be made here to three specimens of vessels, which were probably used for condensing purposes. These were found in the excavation at the Sirkap site, belonging probably to the late Saka-Parthian periods. They are made of coarse, red, sandy clay with lime and broken bricks. This seems to suggest that the process of distillation and condensation was known to the ancient Indians as early as the beginning of the first century A.D. (*cf.* Fig 18*b*).

Certain porcelain-like fragments from Taxila were analysed by the archæological chemist, M. Sanaullah (1920-21). One of these proved to be a variety of quartz and the other, a kind of white glass. A red opaque glass has also been found at Taxila. The results of his analysis are given below

	White opaque glass	Red opaque glass
SiO_2	61.32 per cent	37.09 per cent
Sb_2O_3	5 08 „	—
PbO	—	34 85 „
$Al_2O_3 + Fe_2O_3$	1 70 „	3.16 „
MnO	0.26 „	0 11 „
CaO	9.74 „	6 46 „
MgO	1.64 „	0 70 „
Cu_2O	—	7.20 „
Na_2O	19.26 „	10.33 „
K_2O	1.00 „	0 87 „

The specimens are obviously soda-lime and soda-lime-lead glasses, with the use of antimony oxide and cuprous oxide for the development of the white and red colour respectively. Other specimens from Taxila were also analysed. The results confirm Pliny's statement that the ancient Indians were acquainted with the art of making glass and colouring it by the addition of metallic salts or oxides.

Excavations at Ahichchhatra in the Bareilly district in the Uttar Pradesha have also unearthed types of pottery wares belonging to the 3rd century B C. The wares found at the

various strata show changes in the type, technique and decorative designs, and have been classified into three main groups, —viz., the early, the intermediate and the later groups. Grey wares predominate in the early group. Some of these have a black slip To this group belong the highly polished black or brown sherds of which the earliest associations at Ahichchhatra have not yet been determined. The black polished type is rare. The vessels of this early group are mostly plain with the exception of a few red wares bearing stamped designs. The group is generally charatcerised by the complete absence of painted decoration *of any sort and of any evidence of the use of mould.*

The intermediate group is distinguished by the total disappearance of the grey and black polished wares, the complete absence of the mould technique, and of incised and painted decorations. In these it shares the features of the early group. Decorations were made only by the stamp and consisted mainly of symbols such as are found on Indian coins and sculptures of first century B.C. to the third century A.D. Most of the vessels are found to be devoid of slip or mesh.

The later group forms a large variety and belongs to the period ranging between 350 and 1100 A.D. The objects show utilitarian devices borrowed from earlier models They are predominantly wheel-made with a fair percentage of mould-made pots They are common red wares with red or reddish slip. Vessels of special types are mica-dusted to impart a lustrous and metallic surface. A fairly large number of specimens shows a polished red surface. Decoration consists mostly of rectilinear or curvilinear geometrical patterns, spirals, zigzags and pendants of various types. They are imprinted by moulds or stamps, or are incised with blunt points. The painted specimens of this group show simple designs of narrow or broad bands in black pigment on red grounds.

Excavations at Bhita in the U.P. have also disclosed innumerable potsherds and complete vessels of early ages. Primitive wheel-turned vessels and potsherds are of dark grey clay, often covered with a black mucilaginous paint

or glaze which gives them a metallic lustre, almost like polished steel. These formed the commonest pottery of the pre-Mauryan period, though also found in the Mauryan and later periods. Other potteries of the age are of the common red- and brown-ware type like wares of the later periods.

But the best kind of metallic lustre wares, though few in number, has also been found to belong to the Mauryan, Sunga and Andhra periods. The grey wares become less common than in the previous period. The wares of these periods are made mostly of buff with red slips, or of very fine reddish clay with red paints.

Potteries of the Kushan period found at Bhita are characterised by having bodies of common buff-coloured clay with or without slip. The clay often shows admixture of mica. Water-bottles of fine buff-clay with red paints represent the predominant type.

Potteries of the closely similar character constitute also the findings belonging to the Gupta period. This type continued practically unchanged even up to the Middle Ages.

Excavations at Bangarh in the Dinajpur district of Bengal have revealed pottery rings of 2'-5" in diameter, 8½" in height and ⅜" in thickness used for the construction of ring-well, which may be ascribed to the Mauryan or early Sunga period Polished black pottery characteristic of this period has also been found in abundance here. Burnt bricks of very large sizes, viz., 16½" – 18" × 9½" – 12" × 2½" belonging to the Sunga and Kushan periods (2nd century B.C to 2nd century A D.), and 14" – 15" × 9½" – 13" × 1½" – 9½" ascribed to the Gupta period (3rd century to 5th century A.D), used for building purposes, have been found in abundance at Bangarh. Decorative bricks bearing the figures of men, animals, birds, flowers and foliage of sizes 8" – 9½" × 8" × 2" – 2½" have been discovered in a large number at a somewhat higher level belonging possibly to the later age, namely, the Pala period. Numerous terracotta objects, beads, plaques, moulds, figurines, toys etc., belonging to the Sunga, the Kushan and

the Gupta periods have been unearthed in quantities. Roof-tiles, stamped pottery with designs of lotus and conch-shells and the oval-shaped round-bottomed pottery vases of medium size have also been discovered at a depth which might be ascribed to the Sunga and the Kushan periods. Terracotta and stone beads coated with white paints in designs have been particularly noticed among the findings belonging to the Sunga and the Kushan periods at Bangarh. The paint was probably applied first on the body of the bead and then fixed by heating. *Cf.* Fig. 19.

Evidences have been found at Bangarh of the use of lime and *surkhi* as a mortar for making rammed concrete on the floor of buildings belonging to the Gupta period.

Mention may be made in this connection that a variety of stones, e g., carnelian, chalcedony, quartz, agate, jade, jasper and marble, was used for the purpose of making beads, which belonged mostly to the Mauryan, the Sunga and the Kushan periods.

Excavations at Arikamedu have revealed specimens of ancient potteries, both imported and local, belonging to the early ages in South India. In fact, Tamil literature and Latin geographers speak of the Indian trade in and after the first century A.D. At its prime it was extensive, India exporting pepper, pearls, gem-stones, muslin, tortoise-shell, ivory and silk, and importing from the West coral, lead, copper, tin, glass, vases, lamps, wine, etc. There were European trading settlements in India in those days and navigational data were collected, as Pliny refers to the monsoon. Archæological evidence seems to point to A.D. 30 as the date of the earliest settlement near Pondicherry at Arikamedu.

The imported potteries found at Arikamedu are (*a*) Arretine wares from Italy and (*b*) amphorae from Italy or elsewhere in the Mediterranean. The former seems to belong approximately to A.D. 20—50. The lower strata bear local pottery. The date of occupation of the site has been presumed to lie between the end of 1st century B.C. and the beginning of 1st

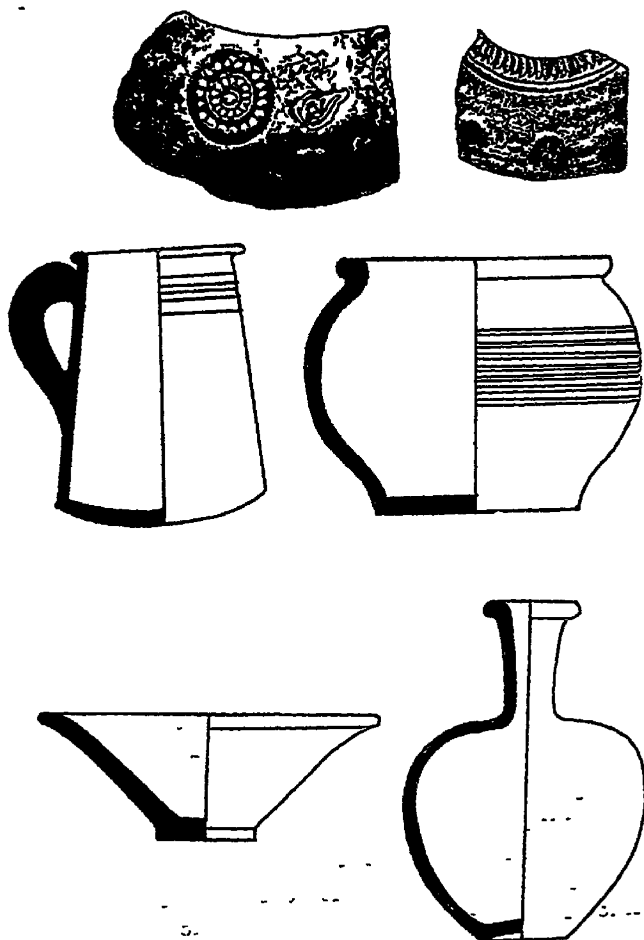


Fig 19 Potteries from Bangarh
(Goswami, *Excavations at Bangarh*, 1948)

century A.D. The terminal date is believed to be near about A.D. 200. The site was later despoiled for bricks in the Middle Ages. *Cf.* Fig. 20 *a* and *b*.

The imported Arretine wares are red-glazed (sealing-wax red to Indian red—a deep orange red). Some of them are decorated by being pressed into a stamped mould. The sherds are, however, generally undecorated.

Imported amphorae are mostly oil and wine vessels Some of the sherds have a pink fabric with yellow slip (150 A.D.).

Some imported wares have been found to be of black colour with smooth surface. They are thin, brittle and well-burnt.

The greater part of the pottery is local and, with a few exceptions, wheel-turned. The exceptions include a class of portable ovens, large troughs and storage jars. The normal degraissants are sand and grit, but mica and straw or husk are occasionally used for this purpose. The fabric was usually a porous clay containing a fair amount of sand which burned pink or greyish red to light red under oxidizing conditions of firing and dull grey to greyish black under reducing conditions in the kiln. For a special class of grey or greyish-pink wares a superior quality of clay, free from grit and remarkably fine-grained, was employed. Slips are fairly common and a fair percentage of the pottery was either salt-glazed or treated with a burnished slip. The vast majority of the types are plain and utilitarian in character. Decorated types are rare and decoration is generally simple and primitive in character, the commonest being finger-tip ornament.

A small percentage of Arikamedu pottery was subjected to inverted firing, i.e., was placed upside down in the kiln with a fair quantity of carbonaceous matter stuffed inside. As a result of the firing the whole of the interior and a portion of the exterior (usually the rim) which came into direct contact with the fuel turned jet-black, and the remaining outer surface became red under oxidizing conditions and

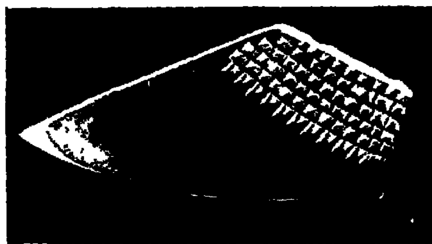
grey under reducing conditions in the kiln. Briefly the former can be called black-and-red ware, and the latter, black-and-grey ware. Very picturesque effects were obtained if the pots were treated with a slip and salt-glazed in course of firing.

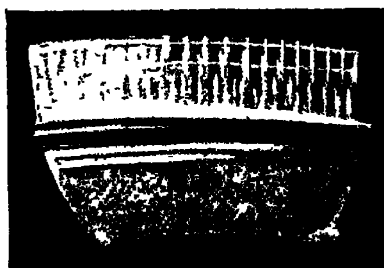
Sherds of Chinese celedon ware have also been picked up at Arikamedu

The general run of the southern wares is of somewhat coarser fabric; and the very highly polished northern black wares are not found in the south

General specimens of pottery found at Arikamedu are glazed, showing the characteristic crackled surface or 'crazing'. The coating of glaze, as pointed out by the archæological survey chemist, does not, however, stand out as a distinct layer, and the glazed effect is only superficial. The specimens were probably salt-glazed. Moist salt was very likely thrown into the kiln, when the fuel was almost burnt out. A few potsherds confined to the pre-Arretine and the lowest Arretine layers show a black slip with a striking metallic lustre The particles of the black film were found by the archæological chemist to be magnetic, which on analysis proved to be magnetic oxide of iron. The same chemist also found fine particles of carbon inside the pores of the sherd. It was concluded by him that a slip of ferruginous clay was applied to the ware and it was heated at a moderate temperature in a smoky fire. A polished, bright-red slip is occasionally found at Arikamedu in potteries of all periods and has been identified as haematite.

Large scale manufactures of beads of semi-precious stones, as also of glass beads, were made at Arikamedu. A bead of faience has also been found. The range of colour of the glass beads is limited; shades of blue and green are the most popular colours, followed by copper-red. Less common colours are white and black, whilst yellow, violet, brown and grey are very rare. The material is generally opaque, but sometimes translucent. Transparent glass is absent.





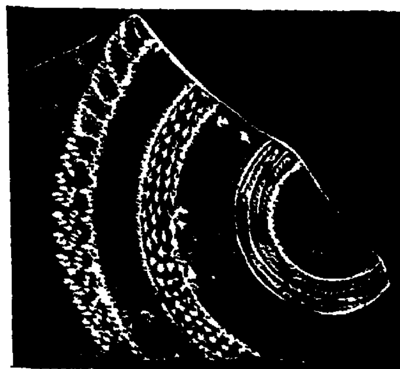


Fig. 20*a*.
Arretine and other potteries from Arikamedu (*Ancient India*, 1948).

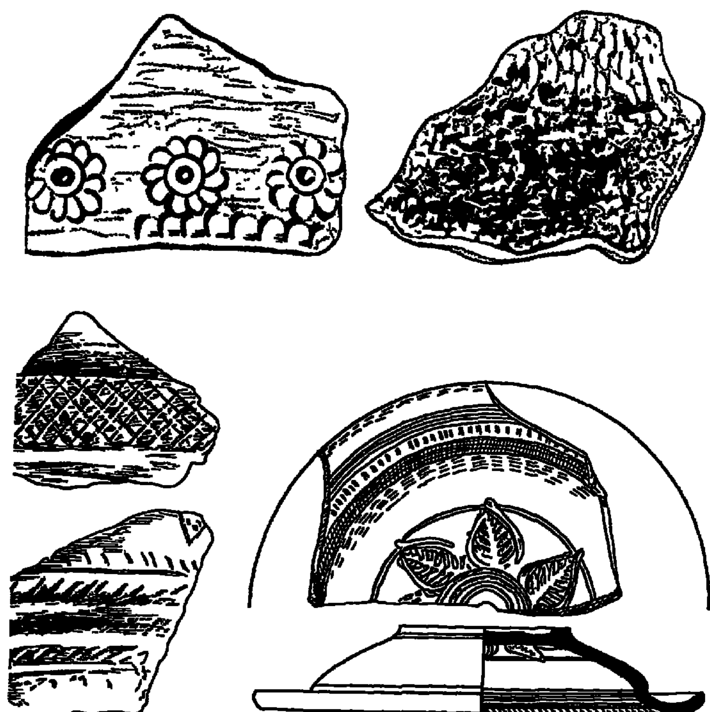


Fig. 20*b* Arretine and other potteries from Arikamedu (*Ancient India*, 1948).

Besides a number of shapeless lumps of iron, a few blades and rings of iron have been found at Arikamedu, as also a copper article.

Discovery of two masonry tanks at Arikamedu leads to the suggestion that they were probably used for the dyeing of cloths.

R.E.M. Wheeler has given an account of the findings in the excavations at Brahmagiri and Chandravalli in the Chitaldurg district of Mysore. These reveal three interlocking cultural levels. The lowest strata correspond to a Stone Age, the intermediate to an Iron Age extending probably from 200 B.C. – 50 A.D., and the uppermost, to what is named the Andhra Culture and extend to the surface. The Andhra Culture is believed to belong to the latter half of the 1st century A.D. as the discovery of certain Roman coins indicates.

The pottery articles of the Stone Age Culture of Brahmagiri are hand-made, have a coarse, grey fabric, sometimes with a thin slip of the same clay. Articles of the earlier phase are painted and incised. The painted sherds have a red or buff slip. Those with red slip are burnished and salt-glazed. The painted decorations are applied after firing. The pigment employed was ochre There appears no resemblance, technically or artistically, to Indus Valley ceramics. Articles of later phase are generally dull mottled grey in colour, coarse and micaceous in texture, and often indifferently baked (Figs. 21 and 22). Copper and bronze rods found in this level indicate some sort of knowledge of their working, but also scarcity of the metal.

Pottery wares of the intermediate Iron Age of Brahmagiri appear to be turned on the slow wheel and have a polished, brightly coloured black-red or all-black surface. A wide range of types has been discovered. The Iron Age strata have yielded a large number of iron objects in a rather bad state of preservation. These consist mostly of knives, wedge-like blades, chisels, sickles, lances, swords, arrow-heads, ring with nails, etc..



Fig 21 Potteries from Brahmagiri
(Ancient India, 1948)

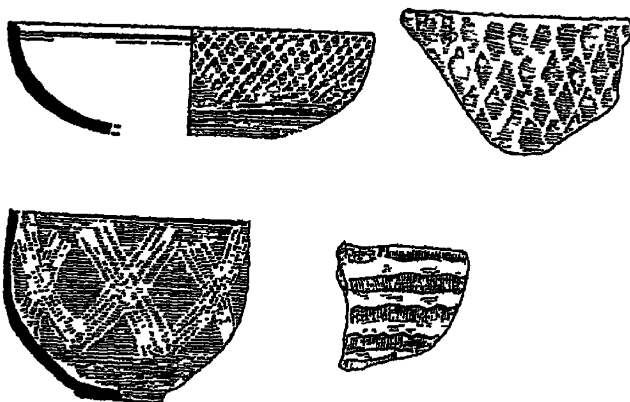


Fig. 22 Potteries from Chandravalli
(Ancient India, 1948)

The uppermost level of the Andhra Culture at Brahmagiri reveals pottery articles of relatively sophisticated type, turned on a fast wheel and coated with a salt-glaze. There is a variety of simple rectilinear or slightly curvilinear patterns in a

paste of kaolin or lime under a wash of russet-coloured ochre. They are coated with a superficial salt-glaze. The colouring material employed is iron oxide.

Glass bangles of this age (uppermost level) have been found both at Brahmagiri and Chandravalli. At Chandravalli numerous Roman coins of this age have been found.

Excavations at Sisupalgarh near Bhuvaneswar in Orissa reveal pottery articles which are essentially plain with no paintings and decorations These are usually wheel-turned. Two types of wares, variations of an essentially integral culture, are noticed. In and above the earliest occupation of the site there occurs a type of a fine polished, bright, well-fired red-ware. This is overlapped in the upper level by a degenerate and crude type of coarser wares characterised by indifferent firing and a red or yellow ochreous slip. But the most distinctive type of article, which may be regarded as the typical of the Sisupalgarh Culture, is a knobbed vessel, a bowl-cum-lid, usually in grey or greyish-black colour with or without concentric groovings on the inner base

Specimens of rouletted wares found at Sisupalgarh bear close resemblances to those of Arikamedu, as also to those of Brahmagiri and Chandravalli. So the age of the earliest specimens would lie at or about 50 A D.

Fragments of glass bangles belonging very likely to the 2nd century A.D. have been found at Sisupalgarh.

Among the metallic objects found at Sisupalgarh mention may be made of a miniature blow-pipe, antimony rods, copper pen and a lead ear-ornament, besides various articles of iron, including nails, spikes, sickles, staples, knife-blades, boxes, lances, spear-heads, daggers, arrow-heads, etc. A number of coins of silver, copper, gold and lead have also been unearthed. With these have been found two disc-shaped moulds of punch-marked coins, made of grey-ware pottery.

Metallurgy and Working of Metals

An account of the art of making pottery and glass has been given above. We now proceed to deal with the achievements of the ancient Indians in metallurgy and working of metals, as illustrated by many ancient and historic monuments still extant in many parts of India, or as recorded in the writings of early travellers from foreign lands, or as can be judged from a consideration of many archæological specimens

Copper

A solid copper bolt, apparently shaped into form by hammer after being cast, has been found in the Rampurwa Asoka pillar near the frontier of Nepal. Historical evidences indicate that it is a product of the third century B.C. The bolt is barrel-shaped in appearance, slightly tapering at the two ends. It has a length of 24½ inches, and a circumference of 14 inches at the centre and of 12 inches at the ends (Fig. 23). The metal is pure copper and is exquisitely worked into shape. The bolt was very likely employed for fixing the large stone capital of the Asoka pillar with the body of the pillar itself. It was presented to the Indian Museum, Calcutta, by its discoverer, W. H. W. Garrick in 1881, where it is still preserved in the Archæological Section

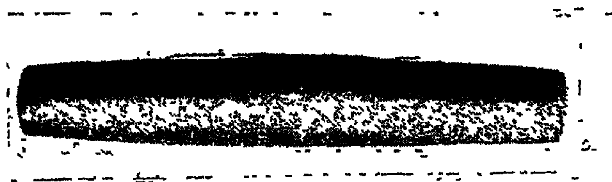


Fig. 23. Copper bolt in the Rampurwa Asoka Pillar
(Neogi, *Copper in Ancient India*)

In the ruins of an old Buddhist monastery situated at Sultanganj in the district of Bhagalpur (Bihar) a large copper statue of Buddha was discovered in 1864 by Mr. Harris, a Resident Engineer of East India Railway. It has a height of 7 ft. 6 in. with a weight estimated to be nearly one ton. The statue is of very pure copper and provided with an outer garment sufficiently transparent to make the body proper visible through it. It seems to have been cast in two layers, the outer layer being cast over the inner one presumably by the *cire perdue* process (Fig. 24). The casting of the inner body was effected in segments on an earthen mould ; these segments are held together by iron bands. From the mode of its construction and from the fact that a coin of the reign of Chandragupta II was found in the neighbourhood of the monastery, it might be concluded that the statue is a product of the 5th century A.D. Among the other articles, found in the vicinity, are the hand of another large copper figure and three small standing copper figures of Buddha besides lumps of copper ore. This seems to suggest that the smelting and casting operations were conducted on the spot. The statue was removed to the Birmingham Museum where it possibly lies still preserved.

The famous Chinese traveller Hiuen Tsang has left a description of a colossal copper statue of Buddha, 80 ft. in height, which he found standing upright near about the famous Nalanda convent in Bihar. According to the Chinese traveller this gigantic copper image, which would approach the bronze colossus of Rhodes island in dimensions, requires a pavillion of six stages to cover it. It is believed to have been constructed during the reign of Raja Purnavarman, the last descendant of king Asoka, a king of the 7th century A.D. This remarkable figure of metallurgical skill must have disappeared very shortly afterwards due to some destructive operation as no further mention of it is found in later chronicles.

There are numerous evidences about the use of copper in early days in India in the form of coins issued by the Greek and Bactrian kings of the 3rd century B.C., as well as



Fig. 24. Copper statue of Buddha at Sultanganj.
(Neogi, *Copper in Ancient India*)

Kushan kings like Kanishka and his successors in the 2nd century A D, and by the Gupta kings of the following periods The earliest coins were punch-marked or stamped with a die. Subsequently, copper coins were evidently made by first casting molten copper in moulds so as to make them of uniform size and then striking between dies.

Punch-marked silver and cast copper coins, usually believed to be the currency of the Mauryan and the Sunga periods, have been found from the lower starta of excavation at Bangarh, already referred to. What appears to be a plumbing bob of bell-metal has been discovered among objects of these

strata. A crucible made of clay (3.55" in length and 2.75" in diameter) has also been found among them.

Copper plates have been in use in India from a very early time. Large copper plates were used in those days in ceremonies associated with the grants of lands by kings to Brahmins and others. Some of these have been found to weigh several pounds. As an illustration, mention may be made of one of the earliest copper plates, Sohgaura plate, discovered in the village of Sohgaura in the Gorakhpur district of the Uttar Pradesha. The inscription on the plate in Mauryan Brahmi script suggests that it must be a product of the 3rd century B.C. The material, however, does not seem to be pure copper, but an alloy of the metal. Other instances of such plates are furnished by those found at Taxila and those bearing the inscription of the Kushan king, Kanishka. Copper utensils have also been used in India from remote times, particularly in connection with religious ceremonies, as the metal copper was held to be sacred by the ancient Hindus. We find their mention in the writings of Megasthenes (3rd century B.C) and of the Hindu Law-giver Manu (early Christian era). Copper caskets for the preservation of relics have also been found buried under stupas and monasteries of ancient times. The metal is not always pure copper but an alloy of the same.

There are ample evidences of copper being smelted on an extensive scale in ancient India. In the Singbhum and Hazaribagh districts of Chotanagpur it is believed, on geological evidences, that copper was mined and extracted some two thousand years ago. According to some geologists, the mining and smelting of copper ores were initiated in this region by the Seraks or lay Jains. Deposits of copper-slags were abundantly found on the hills all around these places. In various places of Rajputana many extinct copper mines are found from which copper was obtained in ancient times. Some of these mines are worked even now on small scales following the old indigenous methods. Nepal was an important source of copper in ancient India. On account of its purity Nepal copper was highly

valued in old days. The old method of manufacturing copper is still prevalent in Nepal and Sikkim. Copper mines were also worked and copper smelting carried out in the Central Provinces, the Kumaun district, the district of Gharwal and in some places of Madras Presidency.

Among the alloys of copper, bronze has been mentioned in the Ayurvedic treatises, the Charaka and the Susruta, and in the Arthashastra of Kautilya. In the Susruta directions are given for drinking water in bronze vessels. Household utensils made of brass have been mentioned in the writings of Manu. The alloy was also employed in making gongs or bells in those early days Hence, no distinction was made at those times between bronze and bell-metal. Both were designated by the same term *kamsya*. Large quantities of ornamental bronze articles have been found as a result of the excavation of the ancient burial sites at Tinnevelly in the Madras Presidency The bronze articles, which were found along with numerous iron implements, include ornamental vase-stands, jars and cups of different patterns with ornamental bowl lids, besides bronze bangles, necklaces, ear-ornaments and diadems. Cricular tubes, a number of sieve cups and perforated strainers for straining rice were also recovered. It is difficult to ascertain the age of their production or of the burial sites in which they were discovered. It is believed that they belong to the time of the Pandiyan kings of the 3rd and the 4th century B.C., when the custom of the urn burial was probably in vogue. Besides being used for household wares and ornamental articles, bronze has also been used in India from early days in casting statues of gods and goddesses. The bronze casters of Bengal in the 8th and the 9th centuries attained considerable reputation and it is said that the knowledge of bronze casting spread later on to Nepal and Tibet through them.

Another important alloy of copper is brass. The Ayurvedic treatise, the Charaka, mentions of it, where it is called *riti*. The same word is also found in the writings of Manu.

Brass articles, belonging to the first century A.D. or near about, have been unearthed by excavations of ancient Buddhistic stupas. A beautifully turned, cast brass casket was discovered in the deposits derived from the excavation of the stupas at Manikyalaya in 1830 by General Ventura. From the inscription on the various articles of the deposits and the accompanying Indo-Scythian coins, the age of the casket has been ascertained to be near about 2nd century A.D. Both bronze and brass were used in ancient India for coinage. Circular punch-marked brass coins of Dhanadeva and Arya-varma of Ayodhya (c. 1st century B.C.) and other brass coins of the same period have been collected and can be found preserved in the Indian Museum. Like bronze, brass was also largely used in early days for making statues of gods and goddesses. An inscribed brass statue of Buddha was discovered in a pilgrim house at Fatehpur near Kangra-kot. It has a size of 30 cm in height and 13.5 cm. in width, and, as the inscription indicates, is a product of the 6th century A D. A very remarkable use of brass for large-scale constructional purpose has been recorded by the Chinese pilgrim Hiuen Tsang. It refers to an unfinished brass *vihara* (convent) near Nalanda made during the reign of Raja Siladitya, known also as king Harshavardhana, in the seventh century A.D. It is stated that this *vihara* would have measured 100 ft. when completed in accordance with the plan. This bears undoubtedly an eloquent testimony to the skill of the ancient Indians in the smelting and working of metals.

Excavations at Taxila have revealed a large number of articles of copper, bronze, brass and lead dating from the 5th century B.C. to the 6th century A.D. These consist mostly of ornaments, toilet articles, household vessels, surgical and other instruments of the Kushan period (Figs. 25, 25 *a* and *b*). Analyses of these by the archæological chemists Mr. Sanaullah and Dr. Hamid are given in Table V below. From a consideration of the analytical results it may be concluded that the composition of soft copper, which was employed for hammered work,

TABLE V

Analysis of metallic objects found at Taxila

Object	Copper	Tin	Arsenic	Antimony	Iron	Nickel	Lead	Zinc	Total
1. Flat bar (6th-7th cent B C)	97.78				1 79				99.57(S)
2. Do (antimony painted) "	87 05	2 01		0 98	9.02				99.06(S)
3 Rod (4th cent B C)	98 33	—	0 19	0 35	0 45	0.51			99 83(S)
4 Plate (1st cent B C)	98 93	—	trace	0 16	0 17	0 52			99.78(H)
5 Spout of a pot (1st cent A.D)	77 45	0 74	0 24	—	0 56	0 43	18.65	trace	98 07(S)
6 Round bowl (3rd cent. B.C)	76 76	21 55	0 16	—	0 95	0 48	—	—	99 90(S)
7 Vase (3rd cent B C)	55 39	4 25	0 26	1 77	0 40	3 08	34.34		99 49(S)
8 Flask (2nd cent B C)	80 38	7 34	—	—	1 33	0 26	7 78	2 49	99 58(S)
9 Bangle (1st-5th cent B C)	76 75	2 58	—	—	—	0 11	6 33	13 07	98 84(S)
10 Bangle (2nd cent B C)	73 72	0 10	—	0 18	0 42	—	5.84	19 78	100 04(S)
11 Filling (bottom of antimony flask, 2nd cent B C)	0 62	0 20	—	0 85	0 35	—	97 98	—	100 0(S)
12 Solder (1st cent A D)	3 11	46 13	—	0 37	0 72	—	49 67	—	100 0(S)
13 Mixing pan (3rd-4th cent A D)	74 24	24 58	0 18	0 02	0 72	0 26	—	—	100 0(S)

S=Sanaullah, H=Dr Hamid

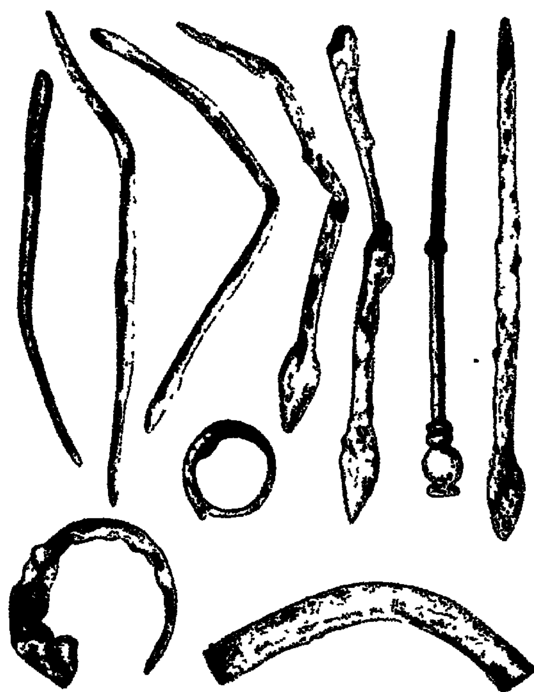


Fig. 25. Copper and bronze at Taxila
(*Ancient India*, 1947).

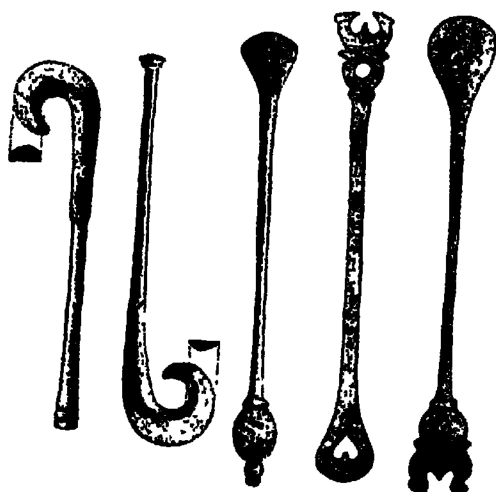


Fig. 25*a*.

Surgical instruments, spatula, etc of copper and bronze at Taxila (Marshall, *Taxila*, Vol. III, 1951).

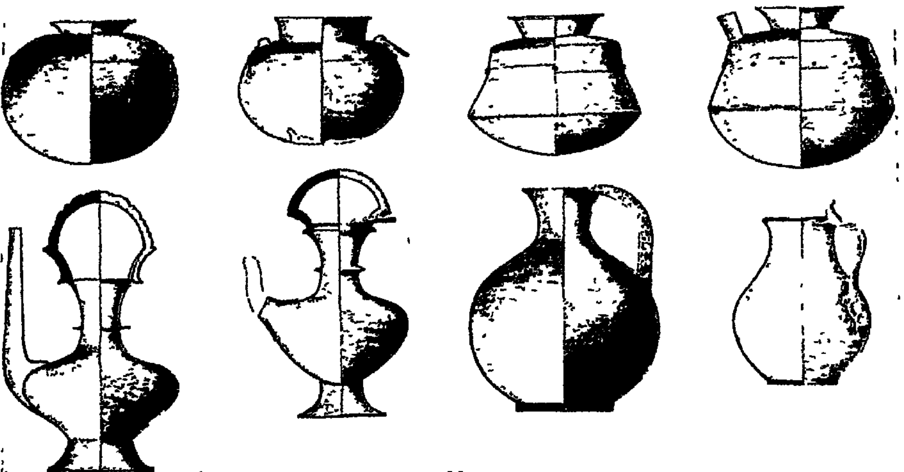


Fig. 25b. Household vessels, cooking pots, jars, etc., of copper and bronze at Taxila (Marshall, *Taxila*, Vol. III, 1951).

shows that the metal was generally of great purity, sometimes reaching 99.7 per cent Bronze, containing 21-25 per cent. of tin was preferred for casting domestic utensils and other articles. This was due obviously to its easy fusibility ; as bronze containing 8-12 per cent. tin, which possesses much greater strength but higher melting point, was employed to a much less extent. Casting in closed moulds or *cire perdue* process was extensively practised.

Brass appears to have been introduced in Northern India quite early, probably through Chinese trade ; but it was later manufactured in India also, by heating copper with calamine and carbonaceous matter. The early specimens with irregular composition were probably made by smelting of mixed ores of copper and zinc, such as exist in China and Sikkim. The later objects having regular composition (13% zinc) were probably manufactured by the calamine method.

A white alloy of nickel and copper was also in use for coinage, jewellery and fancy goods, as the analysis of certain specimens shows. It is identical with the old Chinese alloy, *paitung*, meaning white copper, which was prepared by the smelting of the mixed ores of copper and nickel such as exist in the province of Honan. This alloy was also introduced in India like brass at a quite early date, but appears to have fallen into disuse after the first century B.C.

Solders have also been recovered from some of the copper and bronze vessels found at Taxila. The results of their analysis show that lead and its alloy with tin in equal proportions were used for ordinary soldering.

Excavations at Taxila have also yielded a large variety of silver wares, as well as an abundance of silver and gold jewellery. They may be said to date from the 3rd century B.C. to the 3rd century A.D.

Most of the jewellery from Taxila was made with the help of copper and bronze moulds or dies on which the gold or silver sheeting could be hammered out. The art of granulation and

filigree, as well as that of incrusting jewellery with gems, were known to the metal-workers of Taxila in the 1st century A D, as several jewellery articles of that period with such ornamental designs have been found at the excavation

The discoveries at Taxila leave no doubt that metal industries flourished in India in the first millenium B.C. and that the metallurgical skill had attained a high level during this epoch.



Fig 26 Prehistoric Antiquities in Tinnevelly
Iron swords and daggers
(*Annual Report, Archæological Survey of India*, 1902-3, P 132)

Dealing with the specimens of iron in ancient India reference may first be made to the large number of iron implements and weapons in the form of swords, daggers, tridents, spears, javelins, arrows, spades, hangers, lamps, beam-rods and tripods, unearthed during the excavations of numerous

burial sites in the gravelly mounds of the Tinnevelly district of the Madras Presidency, particularly at Adittanathur. These, as previously stated, are probably the product of the 4th century B.C. (Fig. 26).

Many iron implements and weapons, belonging mostly to the Sunga and the Kushan periods, and a few of the Gupta period, have also been discovered in the excavations at Bangarh, already referred to. Mention may also be made here of many metallic objects, mostly of iron, found in large numbers by excavations at Taxila in 1943-45. These belong probably to the period extending from the 3rd century B.C. to the 5th century A.D. These consist mostly of household utensils, arms and armour, carpenter's and blacksmith's tools, agricultural implements, etc., besides numerous ingots of iron (Figs. 27, 27 *a*, *b*, *c*, *d*, and *e*). Iron pieces in the form of spear-head, spike and nails, found on excavation at Piprahwa in the Basti district of Uttar Pradesha, near the ruins at Kapilavastu and the frontier of Nepal, are regarded as specimens belonging to the 2nd century A.D. Iron clamps, found at the Bodh-Gaya temple (Fig. 28), and the iron slag, found on excavation of the foundation of the stupa at the same place and now preserved in the Indian Museum, Calcutta, furnish evidences regarding the knowledge of the process of manufacturing iron in ancient India as early as the 3rd century B.C.

The famous iron pillar (Fig. 29) near Delhi by the side of the Kutab Minar, which, from a consideration of the script and the text of the inscription on the pillar, is believed to have been constructed sometime in the early 4th century A.D. during the reign of the King Chandravarman of Pushkarana, Rajputana, as a pillar of victory. According to the historians, the pillar was first erected on Mount Vishnupada (probably at Mathura), as given in the inscription; it was afterwards removed to its present site by the king Anangapala II in or about 1050 A.D., when he rebuilt the city of Delhi. The pillar is about 24 ft. l
16.4 in. in diameter at the bottom and 12 in. in diamete

top. The engraved capital at the top is 3 ft. 6 in. in length. The weight of the pillar has been estimated to exceed 6 tons. Analysis of the specimens of the material of the pillar has proved that it is made of wrought iron without any alloy. Specific gravity of the metal, as given by Hadfield, is 7.81, that of the purest wrought iron being 7.84. The results of his analysis, as given in the Journal of the Iron and Steel Industries, are :

Iron, 99.720 ; carbon, 0.080 ; silicon, 0.046 , sulphur, 0.006 ; phosphorus, 0.114 : manganese, —per cent.

Absence of manganese is significant. Low percentage of sulphur indicates the use of charcoal as fuel, as also the purity of the ore. The pillar has wonderfully withstood the influence of rain and air for over fifteen centuries without giving any sign of rust formation. It has been suggested that possibly high phosphorus and low sulphur and manganese content has contributed somehow to its strikingly high corrosion resistance. There might be some truth in it, for in the absence of a second metal the possibility of the formation of galvanic couple is not realized, which constitutes one of the most fundamental conditions for rusting to occur. Or, there might be a thin protective film of magnetic oxide (Fe_3O_4), produced on the surface of the pillar by treatment like heating and quenching after being painted with a mixture of different salts and organic substances. There are evidences of iron being subjected to such treatment for improvement of their quality in some of the ancient alchemical treatises. Expert observers of all classes are of opinion that this pillar presents an indisputable and permanent record of marvellous metallurgical skill and engineering ability of the ancient Indian workers, which can reasonably claim unstinted admiration even of our present time. According to the opinion of the experts the pillar was constructed by welding short pieces of wrought iron previously forged into shapes. The Committee of the Iron and Steel Institute in 1872, which made special enquiries with regard to this pillar, came to the conclusion that iron blooms of about 80 lbs. weight each, produced in a primitive blast



Fig. 27. Iron objects at Taxila (Marshall, *Taxila*, Vol. III, 1951).

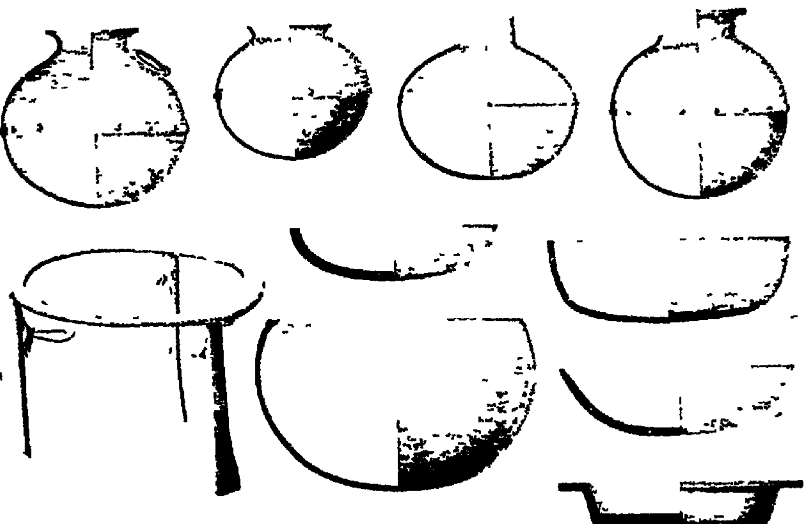


Fig. 27*a* Cooking pots, bowls, dishes, tripod stands, etc. at Taxila
(Marshall, *Taxila*, Vol III, 1951).

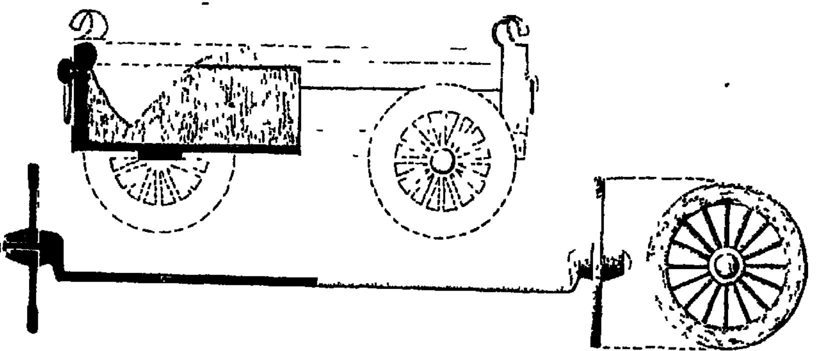


Fig. 27*b*. Wheeled brazier (Marshall, *Taxila*, Vol. III, 1951).

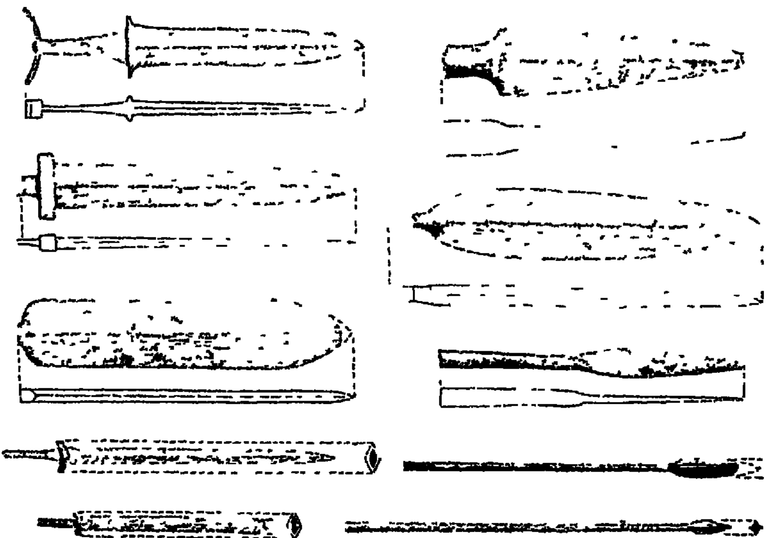


Fig. 27c   Swords, daggers and spears (Marshall, *Taxila*, Vol. III, 1951)

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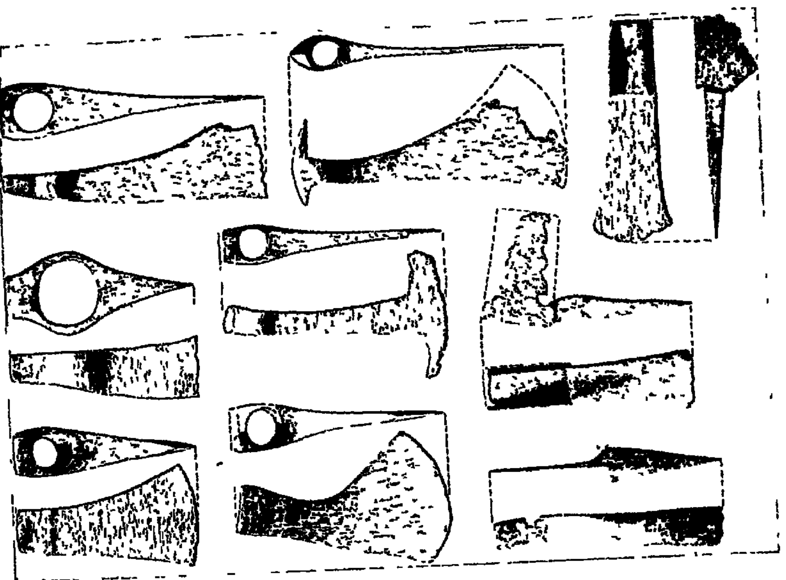


Fig. 27*d*. Tools—Carpenters' and blacksmiths'
(Marshall, *Taxila*, Vol. III, 1951).

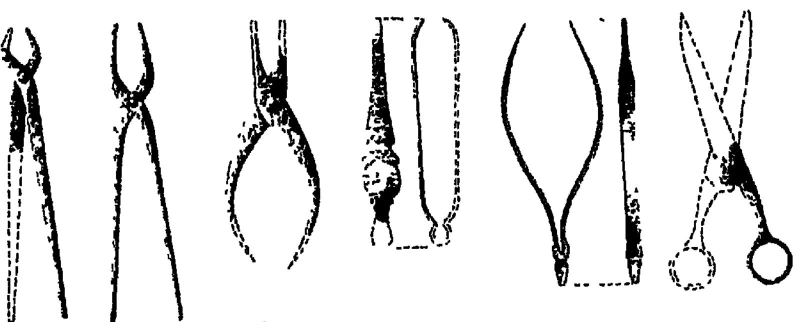


Fig. 27e Tongs, scissors, pliers etc. (Marshall, *Taxila*, Vol III, 1951).



Fig 28. Iron clamps at Bodh-gaya
(Neogi, *Iron in Ancient India*).



Fig. 29. Iron pillar at Delhi

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furnace, were welded together in successive lumps to form the pillar. For, it is not easy even in modern times to forge in a single column such an enormous mass of iron, as represents the Delhi Pillar.

Iron clamps and beams have been extensively used in the joining of long projecting cornices and roof-stones of the magnificent temple at Bhuvaneswar, which is believed to have been constructed in A.D. 640.

Iron produced in ancient India was mostly wrought iron. For, with charcoal as fuel usually employed, the temperature inside the furnace could not have been high enough to melt the metal and thus to ensure absorption of carbon for the production of cast iron. At the low temperature thus prevailing in the furnace, the whole of the ore used, however, was never completely reduced, and a considerable portion escaped reduction. The metal was obtained in the form of a pasty mass or bloom, which was then brought under the hammer to be shaped into bars. The furnace employed was obviously of a very crude type, probably a large hole in the ground over which was built up a circular chimney or shaft with sand and clay; air might be forced into the furnace from the bottom by means of a hand bellow made of goat, sheep or buffalo skin furnished with bamboo tubes. The furnace might have been provided with two openings at the bottom, one for the blast of air and the other for the exit of the slag. Ore and charcoal were piled up in the furnace to start with.

Steel has been prepared and used in India from remote ages. There is no dearth of evidences regarding the high quality of Indian iron and steel of ancient and medieval times. Thus Ktesias, who was at the Court of Persia in the 5th century B.C., mentions two remarkable swords of Indian steel presented to him by the king of Persia and his mother. The Periplus also mentions that in the 1st century A.D. Indian iron and steel were being exported from Africa to Abyssinia. Numerous stone inscriptions of Emperor Asoka, so nicely and precisely executed, suggest the use of fine steel implements

in India in the fourth century B.C. A large number of surgical instruments described in the Ayurvedic treatise of Susruta also furnish indisputable evidence in support of this view. J. M. Heath, in an article (*Journal of Royal Asiatic Society*, 1839, Vol. V, 395) refers to the fact that according to Quintus Curtius a present of steel weighing about 30 lb. was made to Alexander the Great by the Indian Chief, Porus, whose country he had invaded. Obviously, steel must have been regarded as an article of great value in those days. It is believed that the Indian steel was exported to the Western Countries as early as about 2000 years ago. This was known in Europe by the name of *wootz*. It appears that *wootz* has been prepared in India from ancient times in Hyderabad (Deccan), Mysore, Salem and other parts of the Madras Presidency. This was the metal from which the famous Damascus blades were prepared. The Indians of those days were noted for their skill in the tempering of steel, and it was from them that the secret of the operation was learnt by the Persians and, through them, by the Arabs.

Steel was produced in ancient India by a process resembling the modern cementation or crucible process. Wrought iron prepared directly from magnetic iron ore, as already stated, formed the starting material. This was heated in closed crucibles with dry wood chips, stems and leaves of plants over charcoal fire maintained by blowing air with large bellows. The operation was completed in 4 – 5 hours' time, whereas the modern cementation process takes 6 – 7 days. The steel first obtained was heated again in closed crucibles whereby the excess of carbon was burnt off. Sometimes water was poured on the hot metal, which was thus hardened on being quenched. That this gives a correct account of the process in vogue in those early days can be assumed in all probability from the fact that steel was produced by this traditional method, though on a smaller scale, even in the 18th and in the beginning of the 19th century. The well-known conservatism of the Indian people must have served as a strong safeguard against any appreciable change of the original process. We thus find that the knowledge

of the cementation process for making steel was acquired by the ancient Indian workers even before the beginning of the Christian era.

Varahamihira (circa 550 A.D.) has also given some empirical recipes about the hardening of steel (*sastrapana*) :

(1) Plunge the steel, red-hot, into a solution of plantain ashes in whey, kept standing for twenty-four hours ; then sharpen on the lathe.

(2) Make a paste with the juice of the plant arka (*Calotropis gigantea*), the gelatine from the horn of the sheep, and the dung of the pigeon and the mouse ; apply it to the steel after rubbing the latter with sesame oil. Plunge the steel thus treated into fire ; and when it is red hot, sprinkle on it water or the milk of horse (camel or goat), or ghee (clarified butter), or blood, or fat, or bile. Then sharpen on the lathe.—(Varahamihira, *Khargalakshanam* Chap. XLIX, slokas 23,-26).

Dyes and Paints

Among the dyes or colours used by the ancient Indians we find mention of indigo *(nila)*, lac (*laksha*), turmeric *(halidda)*, maddar (*menjettha*) and resin (*rajana*) in a passage in Samyutta Nikaya (part III, p. 152) where Buddha makes an incidental reference to them. The great Sanskrit grammarian, Panini (c. 500 B.C.) also makes mentions of indigo, lac and red-ochre for dyeing cloth (IV. I, 42). The Vinaya text of the Buddhists also describes six sources of dyes for robes : viz., dyes made from roots, trunks, barks, leaves, flowers and fruits of trees. The dye is extracted from these raw materials and the robes are dyed in a dyeing trough (M. VII. 10, 1). Early in the sixth century Varahamihira in the Vrihat Samhita alludes to the preparation of fast dyes for textile fabrics by the treatment of natural dyes like *mañjishtha* with alum and other chemicals (e.g. sulphate of iron), as also with cow-dung :

"*Tubari* (alum) *manjishtha* (maddar) *ragabandhini* (colour-binding)" ; i.e., alum binds the colour of maddar.

It is well known that alum and sulphate of iron are now largely used as mordants in dyeing.

Contents of an ink-pot recovered at Taxila were found on examination by the archæological chemist to contain black carbon mixed with earth. This provides an instance of the use of carbon ink in the Kushan period (*Archæological Report*, 1929, 30, 209).

According to some authorities ink was used in India already during the 4th century B.C. The relic-vase of the stupa of Andher, believed to be of the second century B.C., contains inscriptions written with ink on its surface.

The Kharosthi documents from Khotan also illustrate the use of ink at least in the first century A.D.. Painted inscriptions in the caves at Ajanta serve as an illustration of the use of coloured inks Red lead and cinnabar (*hingula*) were also used as inks. In those early days ink was used for writing on palm-leaf and birch-bark, as the use of paper was unknown. Some of the ancient manuscripts written on palm-leaf and birch-birk, now preserved in various museums and libraries, have been found on examination to be written with indelible black ink.

Cosmetics

In the Vrihat Samhita there is also some allusion to hair dyes, cosmetics, frankincense and scents. There is a chapter on perfumery where various recipes for artificial imitation of natural flower scents such as the essence of *vakula*, *utpala*, *champaka*, etc , are given, and compound scents are arranged in a sort of scale according to the proportions of certain basic scents used in combination for their preparation.

Cements

Vrihat Samhita also describes several preparations of cements or powders called *vajra-lepa* which means literally "paints or coatings as strong as the thunder-bolt", and *vajra-samghata* meaning "composition as hard as the thunder-bolt".

There was ample use for these in the temple architecture of the Buddhistic period, the remains of which bear testimony to the adamantine strength of these cements. From the description given for their preparation and use they are to be regarded respectively as rock-cements (*vajra-lepa*) and metal-cements (*vajra-samghata*).

The process for the preparation of *vajra-lepa* or rock-cements consists in making a concentrated aqueous extract of finely ground fruits, seeds, flowers and barks of plants rich in gummy and resinous substances. This is then again mixed up with naturally occurring resins and resinous substances and made into a paste. The paste is to be heated and applied to the walls of temples and houses for residential purposes. It is stated that this cement will make the things on which it is applied last for a thousand years. In some preparations of *vajra-lepa* an addition of mercury has also been recommended.

In another recipe levigated powder of lac, resinous substances and resin, gummy fruits and plant bodies are made into a decoction with water and then concentrated. This is applied hot.

In a third recipe for *vajra-lepa*, directions are given for making a concentrated extract of animal matters rich in glue or gelatine, such as horns and skins of cows, buffaloes and goats, hairs of ass, mixed with juice of trees like nimba and plantain. The cement is to be finally prepared in the manner, previously described.

The cement *vajra-samghata*, as given in the Vrihat Samhita, is to be compounded of 8 parts of lead, 2 parts of bell-metal and 1 part of brass, melted and poured hot. It is stated that when this type of cement is applied to temples, etc., they last for 1000 years or thereabout. This is obviously a metal-cement (Maya's cement).

Gems and Precious Stones

The use and knowledge of gems and precious stones were known to the early Indians. Mention is made of them in the earliest writings of the Hindus Vedas speak of them; they seem to play a prominent part in the mythologies, traditions, poems and legends. A frequent mention of stones and pearls occurs in the great epics Mahabharata and Ramayana, where they have been described for use as jewels for kings and rich people. In the Vrihat Śambhita of Varahamihira there are chapters on precious stones.

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TRANSITIONAL PERIOD

(800 A D to Circa 1100 A D)

CHAPTER I

VRINDA AND CHAKRAPANI

We now come upon a period which represents a transition in the progress of Hindu medicine so far as the nature and composition of substances used as drugs are concerned. Hitherto herbs and vegetable matters were largely employed as drugs with a few simple and readily available products of the mineral kingdom. From about the beginning of this period and even since the days of Vagbhata we find an increasing use of metallic preparations From the tenth century and downwards every medical work is found more or less recommending compounds of metals which can only be synthetically prepared.

Two notable treatises of this period are the Siddhayoga of Vrinda and Chakradatta of Chakrapani Dutta. Synthetic metallic preparations have received considerable attention in these treatises Both Vrinda and Chakrapani mention Nagarjuna as an authority, and follow closely in the footsteps of Charaka, Susruta and Vagbhata. Nagarjuna is the most conspicuous figure in Indian alchemy and a detailed account of his work will be given hereafter. Influences of the Tantric Cult are also manifest in the writings of Vrinda and Chakrapani.

Chakrapani bases his work on that of Vrinda who again follows closely the order and the pathology of the Nidana of Madhavacharya or Madhavakara. Chakrapani, himself a learned commentator of the Charaka and the Susruta, wrote his work in 1050 A.D It necessarily follows that Vrinda was a recognised authority at least before the time of Chakrapani and was preceded by Madhavakara who possibly flourished in

the 8th century A.D.; for, Nidana was one of the medical treatises translated by the order of the Caliphs in the 8th century A.D. D. C. Bhattacharyya, on the basis of recently gathered evidences, however, placed Madhavakara sometime between 900 and 925 A.D. and Vrinda, between 975 and 1000 A.D.

Chemistry in the Siddhayoga of Vrinda

Mercury has been mentioned as a constituent of a medicine to be applied externally for killing lice. The instruction for the preparation of this medicine is to rub quicksilver with the juice of *Dhatura metel* or *Piper betle*.

The use of copper compounds has been prescribed in the preparation of a collyrium. Killed copper and blue vitriol, rock salt and many other vegetable matter, all in the powdered form, are compounded together for making this collyrium.

This very preparation, in identical recension, occurs in Chakrapani under the name of *Nagarjuna Varti*.

A process of killing iron has been described by Vrinda. For this purpose, iron is to be first ignited in the fire and then macerated in the juice of the emblic myrobalan and *Trewia nudiflora* and exposed to the sun, and again to be macerated in the juice of certain other plants and then to be rubbed in a mortar. The process obviously gives rise to oxides of iron.

A preparation known as *parpati-tamram* has been described as follows. Sulphur, copper and the pyrites are to be pounded together with mercury and subjected to roasting in a closed crucible, and the product thus obtained to be administered with honey. Sulphides of copper and mercury are obviously produced by this operation.

Sulphide of mercury constitutes the main ingredient of another preparation called *rasamrita churnam*. For this, one part of sulphur and half its weight of mercury are to be rubbed together. This is to be administered with honey and clarified butter.

Chemistry in Chakrapani

Chakrapani, in his treatise, has described a number of metallic preparations, of which mention may be made of the following.

Black Sulphide of Mercury (kajjali) or Aethiop's Mineral

The first process consists in the purification of mercury

"Quicksilver, rubbed repeatedly in the juice expressed from *Sesbania aculeata, Ricinus communis, Zingiber officinale* and *Solanum nigrum*, becomes purified".

"Take one part of mercury and one part of sulphur, rub the two together in a mortar and thus prepare *kajjali* or *rasaparpati*." Vrinda has also described a similar preparation under the name of *rasamrita churnam* (*cf.* Chap I)

Tamrayoga (Copper Compound)

"Take a thin leaf of Nepalese copper and embed it in powdered sulphur. The substances are to be placed inside a saucer-shaped earthenware vessel and covered with another. The rims are luted with sugar or powdered rice-paste. The apparatus is heated in a sand-bath for three hours. The copper thus prepared is pounded and administered with other drugs."

The product of the reaction is obviously a sulphide of copper.

Process of Killing Iron

Chakrapani writes "I shall now describe the science of iron promulgated by the sage Nagarjuna." The work of Nagarjuna will be described along with the treatises of the Tantric Period.

The process of killing iron described by Chakrapani consists in rubbing a bar of iron with the levigated powder of various vegetable products like belleric myrobalans, *Clitoria ternatea, Vitis quadrangularis*, etc. It is then strongly heated to the fusion point and plunged into the decoction of the

myrobalans. The iron is then powdered by being beaten with an iron hammer. The powder is then digested in the decoction of the myrobalans and roasted repeatedly in a crucible. The final product resulting from these operations is evidently an oxide of iron in a finely divided state.

Mandura or Rust of Iron

Rust of iron is prescribed in combination with other drugs.

Recipe for a soap to be used as a depilatory has been given by Chakrapani as follows:

The ashes of *Schrebera swietenoides* and *Cassia fistula* are to be mixed with lime from burnt shells and lixiviated with the urine of the ass. The lye is then to be boiled with a definite weight of mustard oil.

The plant ashes, composed mainly of potash carbonate, on treatment with lime invariably produced caustic alkali. The latter, when boiled with mustard oil, gave rise to a potash soap.

Chakrapani has described the preparation of caustic alkali, the process being practically identical with that given in the Susruta.

Calx of Silver

In a preparation named *yogaraja, roupyamal* or calx of silver (probably in the shape of sulphide) figures as a component.

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TANTRIC PERIOD

(From 700 A D. to Circa 1300 A D)

CHAPTER I

A GENERAL SURVEY

Indian alchemy very largely derived its colour, flavour and, in fact, its nourishment from the Tantric Cult. In almost every country the progress of chemistry can be traced to medicine and a belief in the artificial gold-making or the transmutation of the base metals into gold, as well as to the search after the *vital elixir of life* or the *philosopher's stone*. In India, however, these ends have played a secondary part and, in fact, as means to a still higher end, i.e. religious worship, and performance of religious rites. It is well-known that the Indian life in all its aspects, social, political and intellectual, had been at all times under the mighty sway of religion. Medicine and alchemy too, along with the other branches of science, had their origin and growth with this end in view, as necessary aids and helping agents to spiritual pursuit. The ultimate goal of life according to Hindu philosophy and religion is to gain a beatific experience of the Divine in human nature. Health, wealth, vigour and longevity do not constitute the self-sufficient ends of medicine and alchemy, but are pursued for the fulfilment of the ultimate and higher goal of life on the transcendental plane. In the words of Zimmer, "they are prerequisites of the ever-lasting quest, along the paths of pious exercise and austere discipline to win for man a divine freedom beyond all the needs and bonds of human nature".

In all the principal treatises of Hindu medicine of the Ayurvedic and the later periods, this influence of religion and philosophy on the theories and practice of medicine is clearly discernible. This is best illustrated in the Ayurvedic

treatises, the Charaka and the Susruta, where we find an elaborate discourse on the origin of matter and life, and on duties and disciplines of life with a view to its spiritual progress, as well as on other philosophical doctrines blended with medical theories and recipes.

The character of the Hindu medical wisdom and its basis have been beautifully elucidated by Zimmer in his well-known book "Hindu Medicine". The same holds good also for alchemy, which is closely associated with the religious cult of the Tantras. Tantric Cult is characterised by a curious admixture of alchemical processes on the one hand, and grotesque, obscene and sometimes revolting rites on the other—all centred round the worship of Siva and his consort Parvati. The Tantras have thus become the repositories of gross superstitious beliefs, the hideous incantations, sorcery, magic and alchemy, as also of the speculative, metaphysical and esoteric phases of spiritual aspirations. Tantric Cult came into vogue since the decline of Buddhism in India and exercised a considerable influence on the society till the middle ages, circa 1300 A D. But the worship of Siva was recognized from much earlier times, like those of the great epics Mahabbarata and Ramayana. For, there are passages in Mahabharata which make mention of the adoration of Siva under the emblem of the phallus In fact, the phallus-worship may be traced still further back to the time of the Indus Valley Civilization, which possibly in course of time came to be adopted by the Aryans from the so called Dasyus or Dravidians. In some respects, Tantric rites bear close similarity with those prescribed in the Atharvaveda, which, as we have seen, also deals with sorcery, witchcraft, magic, incantations, exorcism of diseases by means of amulets and alchemical ideas. The practice of alchemy, therefore, inspite of its being inseparably linked up with the Tantric rites, had its origin as early as in the Vedic times. Even in Rigveda we find that *soma rasa* (juice of soma plant) has been described as an *amrita* (allied to the Greek *ambrosia*), which conferred immortality upon the gods,

and as a medicine for a sick man. In *soma rasa* and its attributes, it may, therefore, be said that we have the dawn of Hindu alchemy. But it was during the Tantric Period that the practice of alchemy reached its highest development in India.

But there are evidences that alchemical knowledge was widely cultivated in India even before the Tantric age. The Vasavadatta and the Dasakumaracharita in the sixth century allude to the preparation of a mass of fixed or coagulated mercury (*paradapindadraba*—Vasavadatta); of a chemical powder capable of producing deep sleep or stupor by its inhalation (*yogachurna*—Dasakumaracharita); of a chemically prepared wick for producing light without fire (*yogabartika*—Dasakumaracharita); and of a powder which acts as an anaesthetic and paralyses sensory and motor nerves (*stambhana-churnam*—Vasavadatta).

Reference may also be made to the discovery of a Tantra belonging to the extinct school of Kubjikamata and named Kubjikatantra in the valuable manuscript collections of the Maharaja of Nepal. This was written in Gupta character and copied about the sixth century A.D. In one place of this Tantra we come across a passage in which Siva himself speaks of *parada* (mercury) as his generative principle and eulogises its efficacy when killed six times. In this Tantra we find allusions to the transmutation of copper into gold with the aid of mercury, as also to other alchemical processes. Thus, Tantric mysticism with alchemy as an integral part was cultivated even much earlier than 700 A.D., which we have fixed here as the lower limit of the Tantric Period.

There are, however, two distinct classes of Tantras—Brahminic and Buddhistic—dealing in magic, sorcery, alchemy and allied subjects. For, during the period of its decline Buddhism imbibed many of the superstitious beliefs and corrupt rites of effete and popular Brahminical religion. An enormously bulky literature thus sprang up composed by the devotees of both Buddha and Siva. Hinduism too, which has been noted in all ages for its assimilative and elastic character,

swallowed up the remnants of the Buddhists by acknowledging Gautama Buddha, the founder of their religion as an *avatara* or incarnation of Vishnu. We thus find that Nagarjuna, the most conspicuous figure among the Indian alchemists, was a Buddhist by faith.

What is it that made the Tantras the repositories of chemical knowledge ? In contrast to the highly philosophical religion of the Upanishads, accessible only to the upper intellectual classes of the society and according to which salvation or the highest end of life is attained only by right conduct through numerous births and re-births, Tantras offer an easy liberation for all even in this life by enjoining certain rites and ceremonies. Therefore, the ascetic who aspires after liberation in this life must preserve his body for the fulfilment of these rites and ceremonies. According to the Tantras, preservation of the body is achieved by the use of mercury, medicaments and breathing exercises. Tantras, therefore, deal with medicinal preparations consisting mostly of mercury, calculated to make the body undecaying and immortal for the emancipation of a man while alive. In all the Tantric treatises the word *rasa* has been used to mean mercury. Thus they came to be the repositories of many chemical informations and alchemical recipes.

As stated above, the name of Nagarjuna stands pre-eminent among the Indian alchemists The authorship of the renowned Tantric treatise Rasaratnakara is ascribed to him. He is also the reputed author of Kakshaputa Tantra and Arogyomanjari, etc., and the redactor of the famous Ayurvedic treatise, the Susruta. But there is much controversy about the age of Nagarjuna. He is often confounded with Nagarjuna, the founder of the Madhyamika school of Buddhist philosophy and one of the creators of Mahayana Buddhism, who flourished towards the end of the second and the beginning of the third century A D. Rasaratnakara is obviously a Tantra of the Mahayanist school, since its invocations are addressed to all the Buddhas; and in

one place there is pointed reference to Prajnaparamita (perfection of wisdom) appearing before Nagarjuna in a dream and revealing chemical knowledge to him. A feature of this work, specially to be noted, is that some chemical processes are discussed in the form of a dialogue between Salivahana and Nagarjuna, and between Ratnaghosha and Mandavya. These last two names are held equally in veneration with Nagarjuna and grateful acknowledgments to their services occur in later chemical treatises A document in its Tibetan and Chinese version has been found in the shape of a "Friendly Epistle of Nagarjuna to King Udyana". The original in Sanskrit, entitled Suhrillekha, is probably lost. Udyana in the Tibetan transcription is Sadvahana. References to Nagarjuna and his contemporary king Sadvahana are only to be met with in ancient classical literature. This Sadvahana is frequently spoken of in ancient Sanskrit literature as a patron of learning and there are several reminiscences associated with this name. According to Bhandarkar (Early History of the Deccan) the Andhrabhrityas or Satvahanas ruled over the Deccan from B.C. 73 to about A.D. 218. So, if Salivahana of Rasaratnakara be identified with Sadvahana of the classical literature then the age of Nagarjuna and Rasaratnakara should be fixed sometime in the second century A.D.; and Nagarjuna, the founder of the Madhyamika philosophy, and Nagarjuna, the alchemist, should be regarded as one and the same person.

But judging from the internal evidences derived from the treatise Rasaratnakara itself, it can be concluded that this is a typical production representing the Mahayanist period of intellectual activity and must have been composed later than the time of Vagbhata. In Rasaratnakara we find recipes for a number of mercurial preparations, as well as descriptions of processes and apparatuses, of which there is no mention in Vagbhata or any other treatise of that time. We may not, therefore, be wide of the mark if we put down 7th or 8th century A.D. as its latest date. Reference may be made in this connection to the observations made by the great Arabian scholar,

Alberuni about one Nagarjuna, a native of the fort Daihak near Somnath, nearly a century earlier than his own time. This Nagarjuna has been described by Alberuni as a great adept in *rasayana* or alchemy and as the author of a rare book which contained the substance of the whole literature on the subject. If we shift Alberuni's date about Nagarjuna a century or two backwards, then it will tally with the time we have fixed above for the composition of Rasaratnakara. In view of the strength of internal evidences we are inclined to adhere to this later date of 8th century A.D. for Rasaratnakara and its author Nagarjuna. The story of Nagarjuna, the founder of the Madhyamika philosophy, and his friend, king Sadvahana, might have been an imposition, intentionally introduced in Rasaratnakara with a view to impress the stamp of a great and recognized authority on it. In the catalogue of palm-leaf and selected paper manuscripts, belonging to the Durbar Library, Nepal, prepared by H. P. Sastri, we find mention of two other treatises by Nagarjuna, named Yogasara (Catalogue Vol. I, p. 235) and Yogasatak (Vol. II, p. 75). In the former there is a recipe for improving the physical body, and the latter contains recipes for cosmetics and for cure of the diseases of the hair.

Another important treatise of this period is Rasarnava, a Brahminical Tantra of the Saiva cult. Like Rasaratnakara it embodies much valuable informations on chemistry As already stated, Tantras deal largely with mercury and mercurial preparations, the virtues of which have been prominently extolled in Rasarnava, (lit. sea of mercury) Mercury has been described in Rasarnava as of divine origin, being the seed of the god Siva or Hara; in a similar manner mica has been defined as the seed of the goddess Gouri, the consort of Siva; and the combination of the two is held as destructive of death and poverty. Thus we find that alchemy was closely related in India with the Tantric Cult. In fact, the Tantric treatise Rasahridaya speaks of 'rasasiddhas' (alchemists) as those who, without quitting their bodies, have attained to new

ones through the influence of Hara and Gouri (mercury and mica). By the science of mercury is to be understood not only a branch of chemistry alone, but it is also to be applied to salvation according to the Tantric treatises. Mercury, according to Rasarnava, can improve not only the quality of metals (i.e. convert the base metals into gold), but can make the body undecaying and imperishable. Rasarnava is believed to be a Tantric work of the 12th century A.D., which throws a flood of light on the chemical knowledge of the Indians in those days. There are evidences that it has been compiled from pre-existing works; for instance, it has not hesitated, as we find, to borrow copiously from Rasaratnakara of the renowned alchemist Nagarjuna, which we have discussed above. It possesses, in addition, the merit of being the inspirer of several works of the following period, the Iatrochemical Period, notably of Rasaratnasamuchchaya and Rasendrachintamani.

It might be recalled that from the time of Nagarjuna onwards, as Buddhism began to decline in India it appeared to be tinged more and more with Brahminical bias. A notable and decided step in this direction, it appears, was taken by Asamga, a monk of Gandhara, who composed the Yogachara-bhumisastra, in which, by assimilating the doctrines of Patanjali, he paved the way for the growth of Tantras. Asamga seems to have lived about 400 A.D. (*cf.* Takakasu, *J. Royal Asiatic Soc.*, 1905). The absorption of the *yoga* ideas into Buddhistic doctrines made the alliance of Buddhism with Saivaism easy and thus favoured the growth of Buddhistic Tantras. The Mahayanists not only set up their own deities, but borrowed copiously from the pantheon of the Hindus. A picture of the religious and cultural background of the development of Indian alchemy at this period and afterwards is best presented with an extract from the work of an eminent scholar of Buddhistic literatures:

"The decline of Buddhism in India from the 8th century downwards nearly coincides with the growing influence of Tantrism and sorcery, which stand to each other in the relation

of theory to practice. The development of Tantrism is a feature that Buddhism and Hinduism in their later phases have in common. The object of Hindu Tantrism is the acquisition of wealth, mundane enjoyments, rewards for moral actions, deliverance by worshipping Durga, the Sakti of Siva—Prajna in the terminology of the Mahayana—through means of spells, muttered prayers, *samadhi* (suspension of all outward consciousness), offerings, etc Similarly, the Buddhistic Tantras purpose to teach the adepts how by a supernatural way to acquire desired objects, either of a material nature as the elixir of longevity, invulnerability, invisibility and alchemy, or of a more spiritual character, as the power of evoking a Buddha or a Bodhisattva to solve a doubt or the power of achieving in this life the union with some divinity. There is an unmistakable affinity between Tantrism on one side, and the system of *yoga* and *kammatthana* on the other. Tantrism is, so to say, a popularised and, at the same time, degraded form of *yoga*, because the objects are commonly of a coarser character, and the practices partly more childish and more revolting.

"During the reign of the Pala dynasty, there were many masters of magic and "Mantra-Vajracharyas", who, being possessed of various *siddhis*, performed the most prodigious feats. The kings of the Pala dynasty, whose sway over Gauda and the adjacent regions lasted from about A.D. 800 to 1050, are known both from the annals and their inscriptions as protectors of the Faith. It was during that period that the monastery of Vikramsila was a renowned centre of Tantrist learning.

"The Sena kings, who followed the Palas in the dominion over Eastern India, though belonging to Hindu persuasion, were not hostile to the Faith. Still Buddhism declined during their reign, and more so after the invasion of the country by the Mohammedans in A.D. 1200. The monasteries of Udandapura and Vikramsila were destroyed ; the monks were killed, or they fled to other countries The learned Sakyasri went to Orissa

and afterwards to Tibet; Ratnarakshita to Nepal; Buddhamitra and others sought a refuge in South India, whilst Sangama-Srijnana with several of his followers betook themselves to Burma, Camboja, etc. And thus the law of Buddha became extinct in Magadha.

"Many emigrants from Magadha rejoined their brethren in the South and founded colleges on a modest scale in Vijayanagara, Kalinga and Konkan. The comparatively satisfactory condition of Buddhism in the Deccan about that time is attested by the rich donations to the monastery at Dambal."—Kern, *Manual of Ind. Bud.*, pp. 133-34.

It will be noticed that the monks of the monasteries of Udandapura and Vikramsila on their dispersion carried with them their learning and arts in the same manner as the Byzantine Greeks on their expulsion from Constantinople bore with them their intellectual treasures to the Italian cities. In the kingdom of the Deccan and in Tibet the Buddhist refugees found hospitable asylums, just as the Greek philosophers found in the Florentine Republic under the Medicii. From the eleventh century the Deccan thus became the refuge and the centre of literary activity in general, while in the Northern India it was more or less arrested by the inroads and ravages of the Mohammedans. We thus find that Tantric mysticism with alchemy as an integral part was cultivated in the universities of Nalanda, Udandapura and Vikramsila in Magadha and Central India and from thence it spread to Bhot (Tibet) and the regions lying to the south-east of it, and to South India.

The Tantras also found a congenial home in China. Amoghavagra, a *sramana* (Buddhist priest) of Northern India and a Brahmin by caste resided in the Celestial Empire for several years between 746 and 771 A.D., and under his influence the Tantric doctrines dealing with talismanic forms and professions of supernatural power first gained currency there.

It is, however, necessary to remember that on the decline of Buddhism the vigorous impetus, which its followers gave to literature and science, was not lost to India. At the time

of the Brahminical revival Buddhist works of acknowldged merit far from being cast aside were held in veneration. Amarsinha in his lexicon and Vagbhata in his Ashtamgahridaya commence with an invocation to Buddha, which has never shocked the tolerant spirit of the Hindus The Charaka and the Susruta also bear distinct impress of Buddhistic retouching. The Buddhistic Tantras became likewise a part and parcel of Hindu religio-philosophical literature, the subject-matter of the former being incorporated into the latter and the names of Tara, Prajnaparamita and Buddha being *simply* changed into those of Parvati and Siva. In Rasaratnakara *itself* we have distinct indications that it is an admixture of both.

Besides Rasaratnakara and Rasarnava of which we have discussed above, a short introduction to a number of other Tantras of Buddhistic origin, passages from which will be found reproduced hereafter, might be given at this place. These are:

Rasahridya by Govindabhagavat who lived near about the eleventh century A.D. and wrote his book at the request of the king of the Kirataland, i.e. the region adjoining the modern Bhutan.

Rasendrachudamani by Somadeva who culled his materials from pre-existing chemical treatises He has quoted Nagarjuna and others as sources of his inspiration. It was probably written in the 12th or the 13th century A.D.

Rasaprakasa-sudhakara by Yasodhara is another important work of this period. The credit for the accurate observations on the metallurgy of zinc, described in Rasaratnasamuchchaya of the next (iatrochemical) period, really belongs to Yasodhara. Yasodhara quotes from Nagarjuna, Rasarnava and Somadeva. Hence, he must have flourished later than Somadeva and might be placed in the 13th century A.D.

Rasakalpa, which is a part and parcel of Rudrayamala Tantra, likewise seems to belong to this period. The author has confined himself solely to a description of the metals, minerals,

and the process of "killing" them with the agency of various apparatus.

We are now in a position to trace some of the Tantric treatises from their Tibetan translations recorded in the great Tibetan scriptures, Kanjur (*Kang-gyur*) and Tanjur (*Stan-gyur*), the Tibetan equivalent of the Buddhist *Tripitika*. Buddhism was formally introduced into Tibet by Buddhist scholars from Bengal in the beginning of the 8th century A.D., and several of the Tantric treatises were gradually imported into Tibet from this time onwards by Indian scholars. Kanjur and Tanjur represent immense collections of works translated primarily from the Sanskrit and subsidiarily from the Chinese languages, between the 7th and the 13th centuries. These collections are of considerable value, as most of their Sanskrit originals are either lost or now unavailable. The faithful accuracy of these translations and their fidelity to the original enable us often to reproduce the Sanskrit texts and thus provide us with valuable historical data.

Tanjur, though a commentary of Kanjur, is twice as large as the former and consists generally of 225 large volumes. Some parts of Tanjur are believed to date back to the 7th century A.D., though the major portion was composed later. It is divided into two main classes: *Rgyud*, corresponding to the Sanskrit Tantra and *Mdo* or *Do*, corresponding to the Sanskrit *Sutra* (science and literature). Some five volumes of Tanjur are devoted to medicine and some others to astronomy or astrology. We are indebted to the great and heroic Hungarian scholar, Csoma de Koros for his pioneering work on the study of these two famous encyclopædic Tibetan scriptures (*Asiatic Reserch*, Vol. 20, Asiatic Society of Bengal, Calcutta, 1836). In his analysis of the contents of the *Mdo* Csoma has made mention of a work on preparing quicksilver, described as the most powerful agent for subduing every sickness and for improving the vigour of the body, as well as of a work on turning base metals into gold (i.e. on alchemy).

Pandit Vidhushekhar Bhattacharya, in his article on "Sanskrit Treatises on Alchemy as translated into Tibetan" in the *Acharyya Ray Commemoration Volume* (p. 121, Calcutta, 1932) has discussed about these two works and besides has made mention of two more occurring in Tanjur, not mentioned in Csoma's analysis. The Sanskrit names of these four treatises, according to Pandit Bhattacharya, are. (1) Rasasiddhisastra, (2) Dhatuvadasastra, or Dhatuvadasastroddrti, (3) Sarvesvara-rasayana, and (4) Dhatuvada.

The Tibetan translation of the first work is, however, unfortunately lost; only its name occurs in the Tibetan catalogue. The work was composed by Vyadipada and was translated into Tibetan by Narendrabhadra of India and the Tibetan translator Ratnasri of Oddiyana. The second work, according to the Tibetan catalogue, appears to form a part of Vyadipada's work in the opinion of Pandit Bhattacharya. The last two works, Nos. 3 and 4, have been translated into English and published along with the original Tibetan texts in Roman scripts in the Commemoration Volume by Pandit Bhattacharya as already referred to. They were recovered from the xylographs of the Tanjur manuscript of Narthang edition, belonging to the Visvabharati Library. We shall reproduce these along with their Tibetan texts as appendix in our present volume.

The work No. 2, Dhatuvadasastra, has not yet been translated into English. Our attempt to get it translated from the xylographs of the Tanjur manuscript, belonging to the library of the Asiatic Society of Bengal, as also to the Calcutta University Library, did not succeed, as the impressions at several places were practically illegible.

The original Sanskrit texts of these works, preserved in their Tibetan versions, must have been composed at least a century or two earlier than the time of their translation into the Tibetan language and their incorporation into the Tibetan scripture, Tanjur. We-shall, therefore, be not far off the mark

available to us through the recent publication of it by Professor D. V. Subba Reddy of the Madras Medical College. The list has been published in the *Madras Medical Journal* (Vol. II No. 2, April, 1951). It contains the names of 27 works indicating the nature of their contents. Several of these deal with alchemy, medicine and chemistry. Professor Reddy in his publication has added a further list of 38 Tamil books by *sittars*, many of which are known to deal with medicinal preparations, chemistry and physics. A translation of all these works into English is likely to reveal many interesting informations about the knowledge of chemistry in South India in those early days.

From the facts cited above, with particular reference to their chronological order, it will now be recognized that alchemy in India developed all along on independent lines. Its origin and growth were interwoven with a phase of religious activity—the outcome of purely indigenous trait. The progress of magic, witchcraft and alchemy can be traced, as we have seen, from the Atharvaveda onwards to the later Tantras without any breach of continuity, natural to any evolutionary process. The question of Indian alchemy deriving its origin from that of the Greeks and Arabs does not, therefore, arise at all, as suggested by some western scholars. There is, in fact, no evidence that Indian alchemy is of exotic origin. In the Greek doctrines of alchemy, which were adopted more or less by the Arabs, we find the formulation of a mystic relationship between the planets and the metals, the latter being supposed to be engendered in the womb of the earth under the influence of the planets. Each metal, so to say, is begotten by a particular planet. It is idle to look for any such reference in the Indian alchemical or astronomical works.

A great many names of Indian alchemical authors and of their works are scattered throughout the mass of chemical and medical literature, some of which have been handed down to posterity, sometimes on account of the important processes they invented and sometimes, again, because of the efficacy of the metallic preparations introduced by them. We give below the

names of some of the authors and their works over and above those already noticed. It is scarcely possible to submit an exhaustive list.

Author	Work
Anandanubhava	Rasadipika
Balabhadra	—
Bhojadeva	Rasarajamriganka
Brahmajyoti	—
Chandrasena	Rasachandrodaya
Charpata	Charpatasiddhanta
Chudamani Misra	Rasakamadhenu
Dhanapati	Divyarasendrasara
Gahanandanatha	—
Garudadattasiddha	Rasaratnavali
Gorakshanatha	Gorakshasamhita
—	Banddhasarvasava
—	Rasesvarasiddhanta
Harihara	Rasavisvadarpana
Kankali	Rasakankali
Kapali	Rasarajamahadadhi
Kesavadeva	Yogaratnakara
Mallari	Rasakautuka
Manthanabhairava	—
Nandi	—
Narahari	Rasayogamuktavali
Ramaraja	Rasaratnapradipa
(Siddha) Bhaskara	Rasendrabhaskara
(Siddha) Prananatha	Rasadipa
Srinatha	Rasaratna
Svachchhandavairava	—
Trimallabhatta	Rasadarpana
Vaidyaraja	Rasakashayavaidyaka
Vandimisra	Yogasudhanidhi
Vasudeva	Rasasarvesvara
Vyadi	—

CHAPTER II

RASARATNAKARA OF NAGARJUNA

I

I shall now speak of the purification of important *rasas* (minerals).

What wonder is it that *rajavarta* (lapis lazuli) digested with the juice of *Albizzia lebbek* converts silver of the weight of one gunja (*rati*—a kind of seed weighing 1.9 grains approx) into one hundred times its weight of gold of the lustre of the rising sun? 1

What wonder is it that yellow sulphur, purified with the juice of *Butea monosperma*, converts silver into gold when roasted thrice over the fire of cow-dung cakes? 2

What wonder is it that calamine ·· ·roasted thrice with copper converts the latter into gold? 3

Calamine, a zinc mineral, when roasted with copper in the presence of reducing organic matters, is likely to give rise to brass, which was possibly passed as artificially prepared gold.

What wonder is it that cinnabar digested several times with the milk of the ewe and the acids (vegetable acids) imparts to silver the lustre of gold glowing as saffron? 4

Digestion of minerals is to be effected in the decoction of *Dolichos biflorus*, *Paspalum scrobiculatum*, the urine of man and the acid juices of (the fruit of) ratan (*Calamus rotang*) and afterwards with the addition of alkalies (soda, borax, etc.). The operation of roasting is to be performed thrice. 5

What wonder is it that the pyrites macerated in the juice of *Musa sapientum* and in castor oil and clarified butter, and

The numerals at the end of each recipe correspond to the number of verses (slokas) of the original Sanskrit Text.

placed inside the bulb of *Amorphophalus campanulatus* and roasted (in a closed crucible) undergoes perfect purification ? (

The process is likely to lead to the production of metallic copper from pyrites.

Chapala (possibly some sulphur-containing mineral) and other minerals, being macerated in the juice of lemon for 3 days, become purified. Gold being smeared with the five earths, the ashes and salts, and roasted, undergoes purification 12

Silver alloyed with lead and fused with ashes becomes purified. 13

Lo ! it is not to be wondered at that copper, melted with the alkali derived from the earth and the milk of the ewe, clarified butter and one-sixteenth of its weight of oil, will become pure like the crescent of the moon 14

It may be compared to the process for the purification of crude copper by means of 'poling'.

Macerated in the ashes of *Schrebera swietenioides, Butea monosperma* and cow's urine and mixed with the powdered root of *Euphorbia antiquorum*, turmeric……borax, powdered lac and made into balls with the milky juice of *Gymnema sylvestre* and honey, and strongly heated in a closed crucible, *vaikranta* yields its essence. Of this there is no doubt. 23-25

Makshika, (pyrites), repeatedly soaked in honey, oil of *Ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *Musa sapientum*, and heated in a crucible, yields an essence in the shape of copper. A similar treatment has also been prescribed for *tapya* (a variety of pyrites) 25-30

Rasaka (calamine), digested repeatedly with fermented paddy-water, natron and clarified butter, and mixed with wool, lac, *Terminalia chebula* and borax and roasted in a covered crucible, yields an essence of the appearance of tin ; of this there is no doubt. 31-32

Vimala, digested with alums, green vitriol, borax and the watery liquid expressed from *Moringa oleifera*, *Musa sapientum* and finally roasted in a covered crucible in combination with the ashes of *Schrebera swietenioides*, yields an essence in the shape of *chandrarka* (lit. copper of gold-like lustre). 35-36

Darada (cinnabar), when distilled in a *patana yantram* (distillation or sublimation apparatus) into a vessel containing water, yields an essence identical with mercury. There is no doubt about it. 37

Verses 50-51: Dissolution of gems (pearls, etc.) by digestion in vegetable acids, e.g. sour gruel (impure vinegar) and the juice of certain acid plants.

* * *

Here ends Chapter Second of Rasaratnakara by Nagarjuna on the *killing* of diamond and the metals, extraction of the essence of minerals and liquefaction of mica

In the beginning of this chapter we have seen that there are certain recipes, which all refer to the floating mass of traditions current at the time of the author on the transmutation of the base metals into gold. They are quite laconic, and are of fragmentary and disjointed character. The meaning, therefore, is not always clear. Various ingenious methods were resorted to for debasing gold, or making an alloy, which will imitate the character of gold. Silver, copper, lead, zinc and mercury were often made into an amalgam, and the latter rendered compact and coloured yellow with the aid of orpiment. No wonder that the law-books prescribe severe penalties on the fraudulent debasers of the precious metals. Thus according to Manu "the king shall cause a goldsmith, who behaves dishonestly, the most noxious of all the thorns, to be cut to pieces with razors."

II

I shall now explain the process of fixation of mercury. The king of *rasas* (mercury), rubbed with the juice of lime, sal-ammoniac, the acids, the alkalies, the five salts, *Piper nigrum*,

Piper longum, the dried root of ginger, the juice of *Moringa pterygosperma*, the tuber of *Amorphophallus campanulatus*, can readily amalgamate itself with the eight metals. 1

* * *

Prajnaparamita (perfection of wisdom) appeared before Nagarjuna at midnight in a dream and revealed to him the ingredients of a recipe (consisting of steel, copper, mica, pyrites, etc.). 4

Mercury is to be rubbed with its equal weight of gold and then (the amalgam) further admixed with sulphur, borax, etc. The mixture is then to be transferred to a crucible and its lid put on, and then submitted to gentle roasting. By partaking of this elixir (i.e the sublimate) the devotee acquires a body not liable to decay. 30-32.

I shall now describe the *garbha yantram* for reducing *pistika* (a cake of mercury and sulphur) to ashes. Make a clay crucible, 4 digits in length and 3 digits in width, with the mouth rounded. Take 20 parts of salt and one of bdellium and pound them finely, adding water frequently; smear the crucible with this mixture. Make a fire of paddy husks and apply gentle heat.

Recipe for *kajjali* or Aethiops mineral.

The preparation is very similar to those described by Vrinda and Chakrapani 84-86

Having made salutation to all the Buddhas, free from the taint of sins, I shall now deliver the Kakshaputa Tantram for the benefit of suffering humanity.

Now follows a dialogue between Nagarjuna, Ratnaghosha and king Salivahana.

Nagarjuna whose end (salvation) had been attained, benevolent towards all living creatures, blessed with all favours, residing on mount Srisaila

Before him stood Ratnaghosha with folded hands, saying "Be pleased to communicate to me knowledge of chemical operations".

Nagarjuna said :—

"Well done ! well done ! I am pleased with your devotion and shall convey to you all that you want to know, namely, remedies for warding off wrinkles, grey hair and other signs of old age. Mineral preparations act with equal efficacy on the metals as on the body (human system).

* * *

"For the benefit of living bodies I went through all manner of penances for 12 tedious years and worshipped the goddess Yakshini presiding over the *Ficus bengalensis*. Then I heard an oracle :

"Well ! well ! the great sage, I shall give you all that you may ask from me."

Nagarjuna said :—

"O Goddess ! If thou art propitiated, be pleased to communicate to me the rare knowledge of the fixation of mercury."

* * *

Salivahana said :—

"I have dedicated to thee, O Goddess ! treasures of gold and gems, now I await thy instructions."

The Goddess said :—

"Well done ! well done ! O wise ruler ! I shall speak to you of chemical operations performed by Mandavya"—(a well-known alchemist, one of the 27 adepts mentioned in the famous iatrochemcial treatise, Rasaratnasamuchchaya).

"A disciple should be intelligent, devoted to work, sinless, and master of his passions.

"The apparatus known as *koshthi*, mouth blow-pipe, cow-dung, substantial wood (as fuel), a pair of bellows, iron plates, *vidam* (preparation for killing metals),...... having collected all these, chemical operations are to be performed."

Ratnaghosha said :—

"Having prepared with great care 'the powder of projection', which transforms a ten million times its weight of the base metal into gold.... "

Nagarjuna said :—

"I shall convey to you what has been experimented upon by Sakanda."

* * *

Tests for *killed* mercury :—

When the mercury assumes diverse colours after having given up its fluidity, it is known as swooned. Killed mercury is that which does not show signs of fluidity, mobility and lustre. When the quick-silver, which has acquired the colour and the lustre of the rising sun, stands the test of fire (i.e., is not readily volatilized), then it is to be regarded as *fixed* .

Then follows a list of apparatus borrowed from Rasendra-mangala :

Sila yantram, peshana yantram, bhudhar yantram, bansha yantram, nalika yantram, gajadanta yantram, dola yantram, adhaspatana yantram, bhuvaspatana yantram, patana yantram, niyamaka yantram, gamana yantram, tula yantram, kachchapa yantram, chacki yantram, valuka yantram, agnisoma yantram, gandhaka trahika yantram, musha yantram, handica yantram, kambhajana yantram, ghona yantram, gudabhraka yantram, narayana yantram, jalika yantram, charana yantram.

A description of many of these yantrams or apparatuses has been given in later treatises like Rasarnava and particularly in Rasaratnasamuchchaya of the iatrochemical period

CHAPTER III

CHEMISTRY IN RASARNAVA

In Rasarnava, as in all other Tantras, knowledge is imparted in the shape of a dialogue between Bhairava (Siva) and his consort Parvati.

Extracts from Book IV.

On Apparatus and the Colour of Flames.

Sri Bhairava said : "The *rasas* (mercury and some important minerals) and *uparasas* (inferior minerals), the metals, a piece of cloth, *vidam* (preparation for killing metals), a pair of bellows, iron implements, stone pestles and mortars, the apparatus known as *koshti*, mouth blow-pipe, cow-dung, substantial wood (as fuel), various kinds of earthen apparatus (e g. crucibles, etc), a pair of tongs, earthen and iron vessels, weights and balances, bamboo and iron pipes, the salts and the alkalies, the poisons—all these are to be collected and chemical operations begun". (*cf.* Rasaratnakara.)

Dola Yantram: "A pot is half-filled with a liquid and a rod placed across its mouth from which is suspended the medicine tied in a piece of cloth. The liquid is allowed to boil and the medicine is heated by its vapour. This is called *dola yantram*".

An Apparatus for Killing Metals · "Make two iron crucibles each 12 digits in length; the one with a narrow orifice containing sulphur is inserted into the other holding mercury ; below the mercury is placed water (in a separate vessel). The mercury and sulphur should be carefully moistened in garlic juice, which has been filtered through a cloth. The apparatus is now lodged in an earthen pot and another placed over it, the rims being luted with cloth previously smeared with earth. * * Now cow-dung fire is urged. After continuing heating for three

days the apparatus is taken out." This is known as *musha yantram*, which digests sulphur and other substances.

Garbha Yantram :—The description of this apparatus in Rasarnava is exactly similar to that given in Rasaratnakara (vide p. 132). So, it is not repeated here. It is stated that by means of this apparatus mercury can be reduced to ashes in the course of one to three days.

Efficacy of the Apparatus :—"For killing and colouring mercury, an apparatus is indeed a power. Without the use of herbs and drugs, mercury can be killed with the aid of an apparatus alone; hence, an expert must not disparage the efficacy of the apparatus."

Hamsapaka Yantram :—"Take an earthen dish and fill it with sand, and then place another over it · apply gentle heat. Now digest in this apparatus (the ingredients) with the five alkalies, the urines and the *vida*. This is known as the *hamsapaka yantram* by the adepts."

Crucibles :—"Earth of black, red, yellow and white colour burnt husks of paddy, soot, earth from the ant-hill, well-burnt excrements of the goat and the horse · rust of iron......" These are the ingredients used in varying proportions for making crucibles, retorts, etc.

"There are two kinds of crucibles, viz., open and covered (lit. blind) ·the covered one resembles the nipple of a cow and is fitted with a lid, which has a raised head."

"For the purification of silver, the crucible is best made of two parts of the ashes of *Schrebera swietenioides*, and one part each of brick dust and earth."

The porous crucible is of the nature of a 'cupel'.

Colour of Flames :—"Copper yields a blue flame that of tin is pigeon-coloured; that of lead is pale-tinted · that of the iron is tawny ; . that of the "peacock" ore (*sasyaka*) is red."

Sasyaka being blue vitriol (a copper mineral) cannot impart red colour to the flame. The reading in the manuscript seems, therefore, to be defective.

• *Test of a Pure Metal* :—"A pure metal is that, which when melted in a crucible, does not give off sparks nor bubbles, nor spurts, nor emits any sound, nor shows any lines on the surface, but is tranquil like a gem (shows signs of tranquil fusion)."

Kosthi Apparatus :—"For extracting the essence of metals a *koshti* apparatus (vide illustrations) is preferred, which is sixteen digits in width and two cubits in length."

"Here ends Chapter Fourth of Rasarnava, which treats of apparatus, crucibles and the colour of flames."

The Alkalies :—"The three alkalies are the borax, trona (natron) and *yavakshara* (carbonate of potash). The ashes of sesamum, *Achyranthes arpera, Musa sapientum, Butea monosperma, Moringa pterygosperma, Schrebera swietenioides, Raphanus sativus, Zingiber officinale, Tamarindus indica* and *Ficus religosa* respectively are regarded as the standard plant ashes".

V. 35-36

The Maharasas :—"Bhairava said, "*Makshika* (copper pyrites), *vimala* (a variety of pyrites), *sila* (rocks), *chapala* (possibly some sulphur-containing mineral), *rasaka* (calamine), *sasyaka* (blue vitriol), *darada* (cinnabar) and *srotonjana* (stibnite),—these are the eight *maharasas* " VII. 2-3.

Copper from the Pyrites :—"*Makshika*, repeatedly soaked in honey, oil of *Ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *Musa sapientum*, and heated in a crucible, yields an essence in the shape of copper." VII. 12-13.

"*Vimala*, digested with alum, green vitriol, borax and the watery liquid expressed from *Moringa oleifera, Musa sapientum*, and finally roasted in a covered crucible in combination with the ashes of *Schrebera swietenioides*, yields an essence in the shape of *chandrarka* (copper of gold-like lustre").

VII. 20-21

Chapala :—"There are four varieties of *chapala*—yellow, white, red and black. That which has the lustre of gold or silver is most appropriate for the fixation of mercury. The last

two are indifferent and readily melt like lac and are useless. *Chapala* melts like tin when heated over fire—hence the name". VII. 26-27

Brass from calamine and copper is mistaken for gold.

"*Rasaka* (calamine) · There are three kinds of it : namely, of the colour of earth, of the appearance of treacle, and of the colour of stones What wonder is it that *rasaka* mixed with (certain organic matters) and roasted three times with copper converts the latter into gold ?" VII. 31-34

Extraction of Zinc from Calamine.—"Rasaka mixed with wool, lac, *Terminalia chebula* and borax and roasted in a covered crucible, yields an essence of the appearance of tin ; of this there is no doubt." VII. 37-38

Extraction of Copper from Sasyaka.—"Take blue vitriol and one-fourth its weight of borax, and soak the mixture in the oil expressed from the seeds of *Pongamia glabra* for one day only and then place it in a covered crucible and heat in the charcoal fire—by this process an essence is obtained from it of the beautiful appearance of coccinella insect " VII 41-44

Saurashtri.—"Distillation of *saurashtri* (alum). Alum is to be macerated in the bile of the ox one hundred times and then its essence is to be extracted by distillation—a very secret process, not to be divulged." VII. 72-73

The Metals —"O goddess ! listen now to what I say about the metals. Gold, silver, copper, iron, tin and lead ; these are the six metals and their resistance to waste (i e. corrosion) is in the order in which they have been named " VII. 89-90

The Killing of Metals-Vida.—"Hear attentively as I shall now speak of the killing of metals. There is no such elephant of a metal which cannot be killed by the lion of a sulphur." VII. 138-142

Bhairava said : "*Kasisa* (green vitriol), rock-salt, the pyrites, *sauvira* (stibnite), the aggregate of the three spices (namely, black pepper, long pepper and dry ginger), sulphur, saltpetre, the juice expressed from 'malati' (*Echites*

caryophyllata)—all these moistened with the juice of the root of *Moringa oleifera*, makes a *vida*, which would kill all (the metals)." IX. 2-3

"Sulphur, orpiment, sea-salt, sal-ammoniac, borax,—these, digested with plant ashes and urines, give rise to another kind of *vida*."······

·········Having thus collected the ingredients, the chemical operations should be carried out. O goddess! I have told you all, what more do you want to hear?" IX. 9-20

Purification of Quicksilver.—"Quicksilver, rubbed with the juice of the aforesaid plants (21 different plants mentioned in the previous verses) and distilled seven times, becomes pure."

"Quicksilver, made into a paste by being rubbed with copper and subjected to distillation, leaves behind tin and lead (with which they are often adulterated) and becomes pure."

X. 55-56

Killing of Mercury:—"Green vitriol, alum, salt, borax, mixed with the aforesaid vegetable drugs (mentioned in previous verses) kill mercury in an instant (in the shape of calomel)."

XI. 24

Killing of Gold:—"Saltpetre, green vitriol, sea-salt, rock-salt, mustard, borax, sal-ammoniac, camphor, the pyrites—all these are to be taken in equal parts. The crucible is to be smeared with the milky juice of *Euphorbia nerrifolia* and *Asclepias gigantea*, then having added the power of the aforesaid "*vida*", the gold is to be killed, my beloved!".

XI. 83-86

Test for Killed Mercury:—This is identical with what is described in Rasaratnakara by Nagarjuna (q v., p. 134).

XI. 197-198

Colouring of Metals:—"Iron, lead and copper are coloured by means of calamine,—the whole turns into gold". (*cf.* VII. 31-34). XII. 50

"Mercury is composed of the five elements and represents Siva himself." XII. 78.

"Take one pala of the ash of mercury and rub it with the same weight of sulphur and roast the mixture in a covered crucible : thus we get vermilion of the colour of the rising sun." XIV. 81.

"Take the vitriol which is of the colour of the throat of the peacock (i. e. blue vitriol), saffron, calamine, as also the excrement of a young calf, the poisons, powdered *Plumbago zeylanica*, all in equal proportions, rub them with acids and dry in the shade. Having added honey to the above mixture, smear it on a thin sheet of lead. When roasted in a covered crucible, the lead is coloured in no time ; the lead which is now of beautiful colour is fit for bedecking the persons of the gods."

XVII. 70-74.

The process gives rise to an alloy of copper, zinc and lead.

For the illustratoin of the *Kosthi* apparatus or *dola* yantram described in this chapter, see Fig 30, *A and C*.

CHAPTER IV

CHMISTRY IN SARVESVARARASAYANA

(*Translated from Tibetan xylograph by Pandit Vidhushekhara Bhattacharya*)

1. In order to purify quicksilver one should first mix it with the dust of brick (*so. phag. gyi. phye. ma. dan. sbyr*), and crush it seven times. And in that state it is to be kept in the sun.

2. After this it should be purified seven times with the sap (*dugdha or ksira, 'O. ma*) of 'akon' (*Calotropis gigantea*). In that state it is to be kept in the sun.

3. In the same way as before let one proceed with the sap of each of the following plants. 'Varuna' (*sun. ba. run.* actual *ba. un., Crataeva religiosa*), 'kantakari' (*Solanum jacquini*) with its thorns, 'kumari' (*Clitoria ternatea*) 'ghrita kumari' (*Aloe indica*), as well as with the solution of a medicinal salt called *mdzo. tshwa* (in Tibet). The quicksilver after being treated in this way becomes fit for use.

4. Three leaves of 'laingi' (*lingini*, called *sivalinga* in Bengal) which is used as a medicine, and plentiful flowers and stalks of 'katuka' (*katki* in Bengal, *Picrorrhiza kurrooa*) together with an adequate quantity of the sap of 'raktaphala' (Indian fig) poured into a pot, are to be crushed, dried, and made into straight threads

5. One desirous of purifying copper is to make it thin and it is to be steeped in acid (*amla, skyur po'i. nan. du.*) for seven days, and likewise in whey (*dar. ba'i. chur khu. la*) and it becomes glossy (*legs. par. bkra. bar. bya'o*). Then the copper with an equal portion of sulphur is to be put in an earthen pot, so that (when it is placed in fire) no smoke can come out. And then it becomes white just like silver.

This obviously leads to the formation of cuprous sulphide.

6. As regards the purification of *ranga*—tin, (*gsa'. tshe*) one is to use *silarasa*, gum of liquid *Amber orientalis* (*bori. khu. ba*) in the same way as before.

7. One desirous of calcination (*marana*, *bsad.*) of iron should make it thin and put it in the urine of a cow with *triphala*, three myrobalans (*bru. gsum*).

8. One who wants to calcine (*marana*) mica should grind it into powder and put it into acid (*amla*), and then the proceed is the same way as with copper.

9. ... .

10. One who wants to root out skin diseases (*rjo. pha. wan bsad par. ded. pao*) is to be fumigated seven times in the sun with leaves of 'girigandhapatra' (*gandhapatra*=*asvagandha*, *Physalis flexuosa* of a mountain), and he should apply the scum of melted butter. Thus, like the copper mentioned before (the affected part of the body) becomes clean and pure.

11. One who wants to purify silver is to use the fluid of the plant 'nirvisi' (*nir bi. si'i*) seven times, and it is to be calcined just like iron.

12. Lead is to be calcined like quicksilver.

13. One who wants to purify gold is to use the fluid of the plant 'kancana', and it is to be calcined like copper

14. The calcination of *supakita* (?) is like that of gold.

15. Thus when purification is made they are all to be taken in equal proportion with three portions of 'haritaki', *Terminalia chebula*, and there being made a very fine powder of them all, pills are to be prepared. These pills, each of which is of 4 *raktikas* (1 *raktika* = 1 *rati* = 2 grains approx.), if given to a patient, cure all sorts of diseases.

16. The thing mentioned before is to be soaked in acid and in it the flour of parched barley (*phye*) and bread are (also) to be soaked. Then if one takes only four *raktikas* of it, at a time, for six months, one's hoariness of hair and wrinkles of

the body disappear, and one becomes (as beautiful) as the moon ... ..., and a lover's immeasurable love for a woman does not run away. And if a man succeeds (in using the medicine) for six months he does not become languid.

Here ends the *Ratnarasayanasiddhi*.

CHAPTER V

CHEMISTRY IN DHATUVADA

(*Translated from the Tibetan Xylograph by Pandit Vidhushekhara Bhattacharya.*)

1. In order to effect the fulfilment to the fullest extent of charity I shall speak of the teaching (*upadesa*) of Dhatuvada for those who are explorers.

2. *Bilva* (wood apple), *dadima* (pomegranate), and *smantshos* (a kind of dye)—these are to be burnt and mixed with sour wine in a copper pot and kept for three days.

3. Thus there will be a paint, and if it is applied first three times, then seven times, and then twenty-one times to a thin piece of iron it becomes copper.

[The action of sour wine (vinegar) on the copper pot will give rise to a solution of copper acetate; and a piece of iron, when coated repeatedly with this solution, will have a deposit of metallic copper upon it.]

4. Quicksilver, clay for making pottery (*kham. sa*), and *sems. rtsi* (? a kind of paint possibly)—these are to be mixed with cow-dung. Then if a piece of copper is put into that mixture it turns into silver.

(This is obviously an amalgam of copper.)

5. *Asvaksa* (*rta. mig.*, lit. the eye of the horse, a kind of plant), *mesasringa* (*lug ru.*, lit. the horn of a ram, also a kind of plant), *kurmacarman* (*rus. sbob.-sun.-lhags*, lit the skin of a tortoise, probably also a plant), and *sila* (red arsenic) are to be melted with gold, and into that mixture silver is to be put. Then, if with the eighth part of this solution lead is liquefied it becomes silver.

(This evidently produces a gold-silver-lead alloy.)

6. Take silver and *kamsya* (*khar. ba*, bell-metal) in equal portions, and mix them according to the weight of

lead. Afterwards when these are liquefied in a pot, they all become silver.

7. Eight palas (48 gms.) of *mahamamsa* (*sa. chen,* a kind of little shrub), and lead and silver of equal weight, two palas of *sarji* (natron), as well as of *smantshos,* one pala *visaghna sebesten, Cordia myxa* (*dug. bsad*), and quicksilver of equal weight—these drugs are to be crushed with the *rasa* (liquid—*khu. ba)* of the substantial drug. And all these to be put in *svetasringa* (barley—*rwa. dkar*) or in an earthen pot.

8. Then having the mouth (of the pot) tied up one is to burn it, till the fire turns into ashes, and when that substance (lit. the medicine) is taken out it will be found changed into silver, (as bright) as the moon.

9. Having taken the foul matter (i e. pith) inside a stag's horn (*sa. ru* = *mrigasringa*) that has just come into being, keep it in the sun and it will melt. Then (this liquid together) with the powder of lead and silver is to be poured into the clarified butter of a cow (*zum. mar*), and when the water dries up, that matter turns into silver.

10. *Sman. tsha,* 'vida' (borax—*tsha. le*), *yavakshara* (ashes of burnt green barley corn), *sarjika* (natron), the fluid called *svetarasa* (*rtsi. dkar,* mixture of equal parts of buttermilk and water), *visa* (poison—aconite, *dug*) and the urine of a 'hanumat' (large monkey—*ha. nu. man ta'i. chu*)—mix these with buffalo-curd (*ma. he'i. zo*), and keep lead in this mixture for three days, and burn in such a way that no smoke comes out from it (and it turns into silver). And thus on account of the change (of a metal) into silver one's poverty and miseries are removed.

[By this process the surface of lead is possibly coated with a layer of white lead.]

11. Now having described the method of making silver I shall speak of making gold which is just like nectar,

12. In the Himalayas there is a very good and well-known plant called *kustha* (*Costus speciosa—ru. rta*), from the leaf of which drops towards the earth (*sa. phyogs*) a fluid having a colour like bright gold. This and the ashes of pure lead (*sa. ne. dhar. po*), and quicksilver when, according to the instruction given, come into contact with the copper mixed with silver, they turn into gold.

13. First quicksilver is to be put on a fire in such a way that it does not ooze out. Then, when one knowing as to how the paint is to be prepared from drugs (*sman. gyi. rtsi*) (applies it) in (proper) way, there is effected gold. If it (quicksilver) does not remain on the fire it does not turn into gold.

14. Therefore (quicksilver) is to be enclosed (in a vessel), having its mouth covered with a circular stopper, and it becomes gold.

Here ends the *Dhatuvadopadesa* of Acharya Nalina.

(The last line of the verse being defective and obscure has not been translated.

CHAPTER VI

CHEMISTRY IN RASAHRIDAYA OF BHIKSHU GOVINDA

Quicksilver digested with sour gruel and then subjected to distillation is freed from the impurities of lead and tin. 1

Much the same as above. 2..............

A description of the apparatus for the purification of mercury by sublimation and distillation is given in the following verses with details. It consists of two vessels placed one over the other—mouth to mouth, the neck of the upper one sliding over that of the lower with their junctions luted with a composition of suitable materials. This is called *dipika yantram*.

PATALA VII

Ingredients for making a *vida* for killing metals are given here, which are very similar to those described in Rasarnava IX. 2-3 (q.v., p. 139).

The preparation of mild alkali from the ashes of plants is described in the following verses. The process given is rather a poor one, compared to the elaborate description in the Susruta (q.v., p. 63).

PATALA VIII

* * * Alum, blue vitriol—all these severally or collectively are favourable for imparting colour to quicksilver.

Experts (on the properties) of metals are of opinion that tin gives strength, *tikshna* (a variety of iron) colour; lead unctuousness, copper all these qualities (to mercury).

The purport of the verses that follow seems to be that when mercury is rubbed with certain sulphides, e.g. orpiment,

pyrites, etc., and sublimed, it assumes the colour of lac or cochineal insect in the shape of red crystalline sulphide.

PATALA IX

Vaikranta (a mineral resembling diamond, spinel?), *kanta* (a variety of iron), *sasyaka* (blue vitriol), *makshika* (pyrites), *vimala* (a variety of pyrites), *adri* (bitumen?) *darada* (cinnabar), *rasaka* (calamine)—these are the 8 *rasas*, and their essences are well suited for chemical operations.

Sulphur, *gairika* (red ochre), *khatika* (rocky earth), *khechara* (mica), *anjana* (sulphide of lead and antimony), *kankushtha* (a medical earth—possibly magnesium or sodium sulphate) ;—these are the *uparasas* (subsidiary rasas).

Gold and silver are the noble metals.

Copper, brass, *tikshna* and *kanta* (varieties of iron) are the essential or substantial metals : lead and tin emit fetid odours.

The six salts are :— *Sauvarchala* (saltpetre), *saindhava* (rock-salt), *chulika* (sal-ammoniac), *samudra* (sea-salt), *romaka* (probably salt imported from outside), and *vida* (black salt).

The alkalies are :—*Sarjikakshara* (natron), *yavakshara* (potash), and borax.

PATALA XI

A cupel made of bone-ash (goat's), and lined internally with borax, etc......

Giving an account of himself the author writes at the end: [illegible], king of Kirata (lands adjoining modern Bhutan), teacher of mercurial lore, in whom the Goddess of the science of mercury and minerals (chemistry), the source of all good, has taken her abode for the benefit of mankind, who can restore to the disfigured, afflicted with leprosy, the

healthy comeliness and lustre of youth, loaded Bhikshu Govinda, well-versed in chemical operations, with honours; and this Tantra entitled 'Rasahridaya" was composed by him (Govinda).

May Tathagata pronounce his blessings!

This shows that our author was Buddhist by religion.

CHAPTER VII

CHEMISTRY IN KAKACHANDESVARIMATA TANTRA

PATALA i.

In this the (mythical) origin of the Tantra is given.

PATALA ii.

Kakachandeswari said :—

* * * Please, give a brief account of the chemistry of the metals, the killing of mercury and minerals, and the fusion of the gems. 3-4

Sri Bhairava said :—

* * * * Mercury rubbed with the ingredients of the *vida* and roasted in a closed crucible, is *killed* instantly. That mercury now acquires the power of converting a base metal into thousand times its weight of gold. 13-16

Copper, treated with the above preparation of mercury and rubbed with the acids, alkalies and the milky juice of *Calotropis gigantea.*, and roasted in a crucible, turns into gold. 18-20

Verses 21-22 describe the preparation of crucibles from clay free from straw and rocky materials.

Thereafter follows a method for the transmutation of iron into gold—a process not very clear.

PATALA iii.

Liquefaction of Mica :—Thin plates of mica are to be smeared with the three alkalies and borax, and then strongly heated in a crucible The entire mass fuses. * * * * * 29-30

This resembles the modern treatment of refractory silicates with fusion mixture.

CHAPTER VIII

CHEMISTRY IN RASENDRACHUDAMANI OF SOMADEVA

Tests for *killed* iron (rouge):—*Killed* iron (or in general a *killed* metal), when heated with silver, does not mix or alloy with it.

Antimony from Stibnite:—*Nilanjana* (stibnite), mixed with *tikshnam* (cast iron) and strongly heated several times, yields a superior kind of lead, which is readily fusible and is of mild black colour.

The resurrection of the *dead* metal (reduction of the *killed* or oxidized metal) is known as *utthapana* (lit. raising).

Take lead of the weight of 30 palas and rub it with the milky juice of *Calotropis gigantea* and calcine it till its weight is reduced to a *karsha*: this residue, even if it be calcined a thousand times, will not undergo further decay (i e. diminution in weight). Metallurgists call this residue derived from lead *chapala*. (This possibly refers to the extraction of silver from argentiferous lead by a process similar to cupellation.)

Tin also, similarly treated, will yield a *chapala*, which, on merely being touched with the hand, kills or fixes mercury. This mercury is recommended for metallurgical and not for chemical purposes.

One pala of tin should be taken and rubbed with ten *nishkas* of mercury and made into a cake with the addition of zinc; it is then to be digested with the decoction of certain herbs and plants and warm vinegar, and afterwards once more rubbed with half a pala of blue vitriol and the juice of *Abrus precatorius*. The mass is then to be divided into small pills; these should then be put into a crucible with the lid on and the fire to be urged by means of bellows. The essence is then to be taken out of the crucible. This essence of the weight of ten *sanas* is then to be enclosed in a mixture of ashes and

salts, and roasted. This essence of the weight of two *nishkas* is then to be fused with eighty times its weight of lead * * * *. This (essence) is also termed *chapala*. The process obviously gives rise to a brass-like alloy of copper, tin, zinc and lead. Mercury is volatilized during roasting and fusion.

When quicksilver has been deprived of its physical properties (lustre, fluidity, etc.) it is known as *nashtapishta* or killed mercury (*cf.* Rasarnava, p. 139).

Somadeva will now give a brief account of the apparatuses, after having consulted numerous chemical Tantras. (A description of a number of apparatuses is then given, which has been reproduced *verbatim* in Rasaratnasamuchchaya of the Iatrochemical Period ; *vide infra.*)

Urddhvapatana apparatus as described by Nandin (*cf.* Rasaratnasamuchchaya.)

Koshthi apparatus as described by Nandin (See Fig. 30A.).

CHAPTER IX

CHEMISTRY IN RASAPRAKASASUDHAKARA OF YASODHARA

Preparation of Karpurarasa (calomel) :—Prepared from common salt, alum, borax and some vegetable drugs mixed with mercury. The mixture is heated in a closed pot.

Calomel is prescribed here only as an aphrodisiac and a specific for leprosy, but not as a remedy for syphilis.

Rasaka (calamine) :—Two varieties are known ; *karavellaka* and *dardura*.

Extraction of Zinc from Calamine :—The process given is almost identical with that described in Rasaratnasamuchchaya of Iatrochemical Period (*vide infra*). The essence of *rasaka* possessing the lustre of lead runs out of the crucible.

Saurashtri or *tuvari* (alum-earth) :—Found in Surat; when applied to white clothes it serves as a mordant for dyes A variety of it is slightly yellow and is called *phullika*. Another variety is white and acid in taste; this can kill iron. Alum is astringent, acid, beneficial to the eye; it can remove pimples and kill mercury * * * The essence extracted from the alums (i.e. oil of vitriol) is to be used for operations with metals and not as medicine.

Descriptions of various kinds of pits for calcining and roasting purposes are given ; as also their dimensions with the number of cow-dung cakes to be used as fuel, etc

* * *

Here ends Chapter X of Rasaprakasasudhakara by Yasodhara, son of Padmanabha.

Hemakriya or process for the fabrication of gold :— "I shall now speak of some curiosities of metals, partly from my own experience and partly from the classics on the subject. Calamine, cinnabar, copper pyrites and realgar are

to be rubbed with the milky juice of *Euphorbia nerifolia* for seven days together and then to be digested another three days. Melted copper or silver or lead, being alloyed with the aforesaid mixture, acquires the power of converting hundred times its weight of base metals into gold."

CHAPTER X

CHEMISTRY IN RASACHINTAMANI OF MADANANTADEVA

Svetabhasma (calomel) :—The preparation is very similar to that described in the previous chapter for *karpurarasa*.

Two processes for the fabrication of gold are described, which are much the same as already quoted from Yasodhara.

Process for the Fabrication of Silver :—Take one part of bell-metal, two parts of silver, four parts of steel (?) * * these are to be fused with tin and borax ; —by this process silver can be made which will pass current for commercial purposes.

Copper from Blue Vitriol :—Blue vitriol rubbed with three varieties of myrobalans, honey, borax, etc., when heated strongly, gives its essence.

Extraction of Zinc from Calamine :—The process is much the same as given above by Yasodhara, with this difference that, whereas Yasodhara hits off the completion of reduction when the flame issuing from the pot ceases to be blue, the present author directs that the pot is to be taken out of the furnace as soon as white fumes begin to appear. The crucible is then to be held in an inclined position so that the lead-like essence of calamine drops on the ground.

———

CHAPTER XI

CHEMISTRY IN RASAKALPA (RUDRAYAMALA TANTRA)

Bowing to Siva, the lord of mercury, and also to the feet of Chandika, I write this Rasakalpa, the depository of mercurial lore.

I.

Tests for *killed* mercury :—*Killed* mercury is that which is devoid of (metallic) lustre, not so ponderous, white (calomel is probably meant by this), destroyer of metals, divested of fluidity and non-volatile when stirred over a fire. 40

Purified mercury should be preserved in the hollow of a tooth, or gem, or bamboo 42

II.

Gold, silver, copper, tin, lead and iron—these are the six metals; *vartaloha*, etc., are simply alloys 1

Honest readers ! I beseech you with folded hands to favour my book with your merciful glance.

The *maharasas* are eight in number; e.g., mercury, cinnabar, *sasyaka*, *rasaka*, *chapala*, etc.··· The *rasas* are mica, green vitriol, *rajavarta* (lapis lazuli), collyrium, *vaikranta*, borax, etc. Sulphur, orpiment, realgar, etc., are the *uparasas* as regarded by learned teachers.

There are four kinds of sulphur :—white, black, yellow and red.

The *saurashtris* (alums) are of various kinds; the *kasisas* (vitriols) are of three kinds,—namely, *kasisa* proper, *pushpa kasisa* and *hirakasisa* (green vitriol).

Gairika is stated to be of two varieties,—the one of golden hue, the other red; *kamkushtha* and other rasas are also described by certain teachers; but these, however, are

not referred to here, as we are treading in the footsteps of sages of old.

For the purification of mercury this process is recommended by Svachchhandabhairava and Govinda.

Chulikalavana (sal-ammoniac), sulphur and the ash of ginger, etc., digested one hundred times with cow's urine,... make a *vida* for killing gold. This process for killing (metals) was revealed by Siva and has been transmitted by successive schools of adepts

Extraction of the Essence of Copper Pyrites:—*Makshikam* (pyrites), digested hundred times with juice of plantain leaves, and then steeped for three days in oil, clarified butter and honey, and then heated strongly in a crucible yields its essence.

Extraction of Zinc from Calamine:—Calamine, enclosed in fourfold pieces of cloth is heated in steam in a vessel for five months Then it is powdered in a mortar and then mixed with treacle, soot, etc. The mixture is then made into balls. These are enclosed in a crucible and strongly heated. The essence possessing the lustre of tin is thereby obtained.

I have performed the (aforesaid) experiments with my own hands and have seen them with my own eyes. They are not recorded from mere heresay or from the dictation of a teacher. These are being promulgated for the benefit of mankind.

IATROCHEMICAL PERIOD

(1300 A D to Circa 1550 A D)

CHAPTER I

A GENERAL SURVEY

During the Tantric Period, with its system of the "Philosophy of Mercury", a vast mass of chemical information was accumulated, which was pressed into signal service in the period immediately succeeding it—the Iatrochemical Period of India The prominent feature of the former lay in the search after the *elixir vitae* and the powder of projection, as the contents of the Rasaratnakara and the Rasarnava amply testify; whereas in the latter these fantastic and extravagant ideas, impossible of realization, had subsided into something more practical and tangible. The numerous preparations of mercury, iron, copper and other metals, although they could not secure immortality or revive the dead, were found to be helpful accessories in medicine. At first they came to be used cautiously and tentatively, mixed up with the recipes of the Charaka and the Susruta, which were drawn chiefly from the vegetable kingdom; but they soon began to assert a supremacy of their own and even to supplant the old Ayurvedic treatment by herbs and simples. Nay, even absurd pretensions were set up on behalf of these metallic preparations. Thus in Rasendrachintamani, a work probably coeval with Rasaratnasamuchchaya, we come across this remarkable passage: "Revered teacher! be pleased to instruct me, for the benefit of the weak and timid, in a mode of treatment which will dispense with the use of the lancet, and both active and potential cauteries." This is putting in a plea for the indiscriminate use of mercurial remedies.

Rasratnasamuchchaya is a typical production of the Iatrochemical Period. The names of treatises dealing with medicinal chemistry are simply legion. But they are all cast in the same mould, and the close similarity of their contents would

render their translation only a work of supererogation. We have, therefore, confined ourselves to quoting only such parallel passages as are calculated to throw light upon, or corroborate the authenticity of the text of Rasaratnasamuchchaya.

Rasarajalakshmi by Vishnudeva also deserves some prominence here, not because of its intrinsic worth but because of the references to previous Tantras and alchemists; among which are Rasarnava, Kakachandisvara, Nagarjuna, Vyadi, Sachchhanda, Damodara, Vasudeva and Bhagavat Govinda. It was compiled in the latter part of the 14th century.

There is a series of other works belonging to this period, the one characteristic feature of which is that opium is recognised as an official drug in the materia medica portion. These may be taken to date from the middle of the 14th century A.D

Rasanakshatramalika by Mathanasimha, physician to the king of Malwa, should find a mention here; the date given for the copy of the manuscript is *Samvat* 1557, i.e. 1500 A.D. The work itself is therefore older.

Rasaratnakara by Siddha Nityanatha, son of Parvati, comes next in order. The author gives the sources of his information and explains the object of his compilation in the following words: "Whatever has been revealed by Siva in Rasarnava under the preparations of mercury; the Dipika of Rasamangala on mercury; all that has been said by Nagarjuna for the benefit of the people afflicted with diseases, as also by Siddha Charpati, by Vagbhata and Susruta,—all these and many other treatises on mercury and minerals being consulted, I have, after rejecting the drugs and medicaments which have become rare and difficult to procure, put together (in my work) the essential features thereof. * * * All that I have learned from my teachers and have been in a position to subject to practical tests has been incorporated into my work for the benefit of mankind." In addition to the authorities cited above Nityanatha quotes from Chakrapani and Rasendrachudamani.

Rasendrachintamani next claims our attention. There is much dispute over its authorship, and no direct information is

available about the time of its composition. The author refers to Rasarnava, Nagarjuna, Govinda, Nityanatha, Siddha Lakshmisvara, Trivikramabhatta and Chakrapani.

Rasasara is an important treatise of this period. It is a comprehensive but purely chemical work dealing with 18 operations on mercury · various chemical processes are incidentally described, a good many of which, however, overlap each other The author, Govindacharya, as a devout Hindu begins with his adoration of Siva and Vishnu, and tells us at the outset that his treatise is a composition and epitome based upon standard works on the subject and the contribution of the adepts It is interesting to note that he declares his indebtedness to the Buddhists of Tibet for a knowledge of certain processes This seems to indicate that the cultivation of alchemy and chemical knowledge had become neglected, almost forgotten, in India proper, and the earnest searchers for the lore had to repair during the time of our author to Tibet. Confirmatory evidence to the effect is equally furnished in the colophon to Rasahridaya of the previous period. We have already discussed that during the decadence of Buddhism and the corresponding ascendancy of Brahminism in Bengal, circa 11th to 13th century A D, this branch of science found a safe retreat in the land of the Kiratas The work is very likely a product of the 13th century A D, and there is mention of opium in it. But the author was evidently quite in the dark as to the origin of opium, which he believed to be derived from certain kinds of poisonous sea-fish or snakes (The Sanskrit word for opium, *ahiphena*, lit foam of the snake.)

Another well-known treatise is Sarangadhara-samgraha —a compilation by Sarangadhara Its peculiarity is that it is based upon the Ayurvedas (the Charaka, etc.) on the one hand and the Tantric chemical treatises on the other. In the chapter on the purification and incineration of metals, seven of these are recognized ; but, strange to say, there does not occur any mention of zinc Later on, nine metals are named including two alloys, brass and bell-metal, after the nine planets, the

significance of which will be discussed in the proper place. The date of Sarangadhara can be ascertained with accuracy, as besides this medical compendium he is the author of the "Paddhati", a voluminous miscellany containing with other matters a poetical anthology. The author dates his work in *Samvat* 1420 or A.D. 1363. The name of the author's father is Damodara and that of the grandfather, Raghavadeva, who attended the court of Raja Hammira, the Chauhan.

Rasendrasarasamgraha by Gopalakrishna, also a treatise of this period, is more or less a compilation based upon many Tantras, though the author mentions only two of them; namely, Rasamanjari and Chandrika In this treatise special stress has been laid on the therapeutic efficacy of mineral preparations. Like Rasendrachintamani it assigns a minor place to the ancient Ayurvedic method of treatment by *kashayayoga*, i.e., by herbs and simples; as far as the knowledge of chemical processes goes, it must be held inferior to the former Numerous medicinal recipes agree word for word with those in Rasendrachintamani, which only proves that both have drawn on a common stock There is no question of the one borrowing from the other, as both belong to the same period. This work is very popular in Bengal.

Rasendrakalpadruma is another work of this period. It deals chiefly with mineral preparations and is a mere compilation from Rasarnava, Rasamangala, Ratnakara, Rasamrita and Rasaratnasamuchchaya; the numerous citations with which it is replete are of some use in correcting many doubtful readings in these latter.

Another treatise of this period which deserves mention here is Dhaturatnamala. This epitome is devoted exclusively to short processes of killing metals and minerals. Six metals are recognized at the outset, namely, gold, silver, copper, lead, tin and iron, as in the ancient works, but, strange to say, later on *kharpara*, which is the mineral calamine, is taken as synonymous with *jasada* or zinc. The author is one

Devadatta of Gujrata. This work cannot be placed earlier than the 14th century.

The latter part (1500–1600 A D.) of the Iatrochemical Period, representing practically the final phase of Hindu Chemistry and Materia Medica, is characterised by the fact that over and above opium, some other foreign drugs were incorporated into its pharmacology. By the beginning of the 16th century A.D. the Portugese had fairly established themselves at Goa and some other parts of India, and as a result of intercourse with them, that dreadful scourge—the venereal disease—had made its appearance. Sanskrit medical treatises, from the Charaka and the Susruta downwards and ending with Sarangadhara, are silent about the malady, though they give fairly accurate descriptions of diseases of the genital organ (*upadamsa*) But syphilis had now to be reckoned with and a new name had to be coined for it. Accordingly we find Rasapradipa, one of the standard works of this period, given to Tantric method of treatment, prescribing calomel and *chobchini* (China root, *Smilax china*) for what is now termed for the first time *phirangaroga* or the disease of the Portugese. The use of this drug as a remedy for syphilis, it is believed, was made known to the Portugese at Goa by Chinese traders about A.D. 1535. This indirectly furnishes us an approximate date for the composition of Rasapradipa This work also gives us a detailed process for the preparation of mineral acids by distillation, which the author names *samkhadravaka* (lit a solvent for conch-shells). This is described as a substance endowed with the property of dissolving metals. It is thus evident that the use of mineral acids as a solvent for metals was unknown in India before this time.

Rasakaumudi is another compilation belonging to this period and as far as its contents go it is comparable to Rasapradipa in many respects Both opium and mineral acids are prescribed in it.

The next work which should now claim our attention is the well-known Bhavaprakasa of Bhavamisra It is a

voluminous compilation in which the Ayurvedic method of treatment has been adopted mainly, and ample citations are given from Charaka, Susruta, Vagbhata, Harita, Vrinda and Chakrapani One or two chapters have also been devoted to mineral preparations; but these have been borrowed chiefly from Rasapradipa, Rasendrachintamani, Sarangadhara and other standard works. *Phirangaroga* has also been mentioned, as also its treatment with calomel (*rasakarpura*) and *chobchini* The author lived about the time of the Emperor Akbar and evidently in that part of India which is now known as the Uttar Pradesha. It is, therefore, not to be wondered at that Muslim influence is discernible in his book

A remarkable production of this period is, however, the treatise entitled Dhatukriya or "operations with metals." It is in the shape of a dialogue between Siva and Parbati; in short, it pretends to be a part and parcel of the Rudrayamala Tantra. The work cannot be placed earlier than in the 16th century A.D., as it contains reference to the countries of the *Phirangas* and to Ruma, the Arabic name for Constantinople (Istambul). For the first time we come across the very appropriate term *dahajala* (lit. burning water), coined to denote sulphuric acid. The information about the metals is of very meagre and poor description, and it has been needlessly spun into an inordinate length.

Arkaprakasa or a treatise on the preparation of medicinal tinctures and essences should also find a place here. Its authorship is ascribed to Ravana, the mythical king of Ceylon. The contents of the work, however, reveal its date. For instance, mercury, treated with *samkhadravaka*, is prescribed as the remedy for *phirangaroga* (syphilis) Opium is also found in its prescriptions; while the term *jasada* is used to indicate zinc. As a distilling apparatus, tinned copper vessel has been recommended Mahommedan influence is distinctly discernible in this hybrid production. The very title of the book is evidently Sanskritised from the Persian *arrak* (essence).

References may finally be made to some other works of this period, viz. Rasamanjari by Salinatha, Rasaranjana, Gandhakakalpa (a Tantra), Rasarnava (quite distinct from the standard alchemical work bearing the same title), and Rasaratnakara (different from that of Nityanatha). But there is nothing new in them, as they all repeat the processes already described.

CHAPTER II

CHEMISTRY IN RASARATNASAMUCHCHAYA

BOOK I

Salutation to him—the excellent, the greatest physician of the world, by the nectarous ocean of whose benign glance, resplendent with brilliance, born of everything that is joyous and auspicious, and which acts like unfailing elixir, the diseases of his devotees, such as birth, death and old age, and worldly attachment are cured in an instant. (The salutation is strictly Buddhistic.) 1

Adima, Chandrasena, Lankesa, Bisarada, Kapali, Matta, Mandavya, Bhaskara, Surasenaka, Ratnakosa, Sambhu, Sattvika, Naravahana, Indrada, Gomukha, Kambali, Vyadi, Nagarjuna, Surananda, Nagabodhi, Yosodhana, Khanda, Kapalika, Brahma, Govinda, Lampaka and Hari—these are the twenty-seven experts on alchemy as also Rasamkusa, Bhairava, Nandi, Sachchhanda-bhairava, Manthanabhairava, Kakachandisvara, Vasudeva, Rishyasringa,—the compiler of alchemy, the ascetic Rasendra-tilaka, Bhaluki, who has got the appellation of Maithili, Mahadeva, Narendra, Ratnakara and Harisvara. 2-7

This treatise on well-tried mercurials and minerals, named Rasaratnasamuchchaya, adopted to the treatment of diseases, is being compiled by the son of Simhagupta, after having consulted the works of the aforesaid adepts and others. It will treat of mercury, the minerals and the metals, the construction of the apparatus, the mystical formula for the purification of the metals, the extraction of the essences (active principles), liquefaction and incineration. 8-10

(Here follows a description of the virtues of mercury and its mythical origin).

By partaking of mercury, men are freed from a multitude of diseases, arising out of the sins of former existence—of this there is no doubt.

He who falls foul of mercury, which is the generative principle of Siva, will rot in the hell aeon after aeon

26

From the mouth of the God of fire * * * * mercury dropped into the country of Darada (Dardistan, the mountainous region about Kashmir, is famous for the ores of cinnabar ; *darada* is in fact a name of cinnabar), and it has there remained ever so long The soil of that region, on being subjected to distillation, yields mercury. 89-90

Here ends Book First of Rasaratnasamuchchaya, composed by Vagbhata, son of Simhagupta, prince of physicians

Book II

The Rasas

In the Hindu Materia Medica the mineral kingdom is broadly divided into the *rasas*, the *uparasas*, the *ratnas* (gems) and the *lohas* (metals). The term *rasa* is in general reserved for mercury, though it is equally applicable to a mineral or metallic salt. In the oldest medical works, e g the Charaka and the Susruta, *rasa* has the literal meaning of juice or fluid of the body, which, according to the notions of humoral pathology, engenders blood, serum, sweat, etc *Rasakriya* in the Susruta means fluid extract or concentrated decoction. As mercurial and metallic preparations gradually came into vogue and even began to supplant the vegetable drugs, the term *rasa* began to be substituted for quicksilver on account of its semi-fluid character and its supposed miraculous therapeutical action on the juices or humours of the body In the Bhavaprakasa we find *rasa* used in a twofold sense,—ancient and comparatively modern.

In the older works *rasayana* (derived from *rasa*, juice, and *ayana*, way) means a medicine preventing old age and prolonging life—the *elixir vitae*. Later on *rasayana* was almost exclusively applied to the employment of mercury and other metals in medicine, and at present it means also alchemy

(chemistry). The author of Rasaratnasamuchchaya uses the term "Rasasiddhipradayaka", which is derived from *rasa*, mercury, *siddhi*, accomplishment, and *pradayaka*, giver or bestower, i.e. lit. giver of accomplishment in mercury; in other words, an expert on alchemy. Wilson in his Sanskrit-English dictionary thus happily renders *rasasiddhi*: "The knowledge of alchemy, the possession of peculiar familiarity with mercury obtained by the performance of chemical operations conjoined with certain mystical and magical rites and the securing thence to the adept of happiness, health and wealth; the power of transmuting metals and the art of prolonging life."

Abhra (mica), *vaikranta*, *makshika* (pyrites), *vimala*, *adrija* (bitumen), *sasyaka*, *chapala*, and *rasaka*: these 8 *rasas* are to be identified and collected.

ABHRA

There are three varieties of mica, namely, *pinakam*, *nagamandukam* and *vajram*, and each of these again are of four different colours—white, red, yellow and black. 5-10

Mica, the layers of which can be easily detached, is preferred. Mica, which is as bright as the moon and which has the lustre of the rust of iron, does not take up or combine with (lit. swallow) mercury. That which has taken up mercury can alone be used with the metals and administered in medicine. Mica, which has been killed, is prescribed in the treatment of various diseases. The variety, which has the lustre of the moon, if taken internally, brings on dyspepsia and urinary disorders. 12-14

Mica, heated seven times and plunged into sour gruel, or cow's urine, or decoction of the chebulic myrobalans, or cow's milk, is freed from all impurities. 17-18

Mica, mixed with paddy grains and reduced to powder, tied in a piece of cloth and suspended in sour gruel, and then passed through linen, is known as *dhanyabhram* (lit. mica in

combination with paddy). *Dhanyabhram*, rubbed with the juice of *Cassia sophera* and roasted ten times in a closed crucible, is killed thereby 24

VAIKRANTA

Vaikranta has eight faces and six angles, is slippery and heavy and of uniform or mixed tint. It has 8 different colours, viz., white, red, yellow, blue, with the shades met with in the down of the pigeon, grass-green, black, and variegated. 55-56

Vaikranta is a powerful tonic and reckoned among the sovereign medicines It is a destroyer of all disorders and is employed in the place of diamond. 57-58

Vaikranta is purified by being heated three days with the salts and the alkalies, or by digestion with the acids, urines or decoction of *Dolichos biflorus* and the plantain, or of *Paspalum scrobiculatum*. It is killed by being roasted in a covered crucible eight times in combination with sulphur, lemon juice and *Paspalum scrobiculatum*. 67-68

Vaikranta, after being heated and plunged into the urine of the horse, ought to be repeatedly roasted and then reduced to ashes 69

Vaikranta after incineration is substituted for diamond. 70

Macerated in the ashes of *Schrebera swietenioides, Butea monosperma* and cow's urine, and mixed with the powdered root of *Euphorbia antiquorum*., turmeric. borax, powdered lac, and made into balls with the milky juice of *Asclepias geminata* and honey, and strongly heated in a closed crucible, *vaikranta* yields its essence. Of this, there is no doubt 71-72

COPPER PYRITES

Makshikam is born of mountains yielding gold ......and is produced in the bed of the river Tapi and in the lands of the Kiratas, the Chinese and the Yavanas. 77

Pyrites is of two kinds—golden and silvery: the former is a native of Kanouj and is of golden yellow colour. The silvery pyrites is associated with stones and is of inferior quality 81

Rubbed with the juice of lemons and sulphur, and roasted in a closed crucible it is killed. 84

Makshika, repeatedly steeped in honey, oil of the seeds of *Ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *Musa sapientum*, and gently roasted in a crucible, yields an essence in the shape of copper. 89-90

(These verses occur both in Rasaratnakara by Nagarjuna as well as in Rasarnava ; see pp. 130 and 137.)

VIMALA

Vimala is described as of three kinds according as it has the lustre of gold, silver and brass respectively 96

It is rounded and is also endowed with angles and faces. 97

It is killed by being roasted ten times with sulphur, bitumen, *Artocarpus lakoocha* and the acids. 100

Vimala, rubbed with borax, the juice of *Artocarpus lakoocha* and the ash of *Schrebera swietenioides*, and roasted in a covered crucible, yields an essence of the appearance of gold. 101

Vimala digested with alum, green vitriol, borax and the watery liquid expressed from *Moringa oleifera*, *Musa sapientum* and finally roasted in a covered crucible in combination with the ashes of *Schrebera swietenioides*, yields an essence in the shape of *chandrarka* (lit. copper of gold-like lustre) 103-104

(These two couplets occur both in Rasaratnakara by Nagarjuna as well as in Rasarnava ; see pp. 131 and 137.)

SILAJATU

Silajatu (bitumen) is of two kinds, – one having the smell of cow's urine, the other resembling camphor. It oozes out in the heat of the sun at the foot of the Himalayas from the bowels of gold, silver and copper respectively 109-111

SASYAKA

Sasyaka (blue vitriol)... has the play of colour in the throat of the peacock (i e has blue tint). *Mayuratuttham* is an emetic, an antidote to poisons and a destroyer of the whiteness of the skin 127-129

It is killed by being roasted in a covered crucible with the juice of *Artocarpus lakoocha*, sulphur, bitumen and borax. 132

Extraction of Copper :—Take blue vitriol and one-fourth its weight of borax and soak the mixture in the oil expressed from the seeds of *Pongamia glabra* for one day only and then place it in a covered crucible and heat in the charcoal fire,—by this process an essence is obtained from it of the beautiful appearance of coccinella insect 133-134

(These two couplets have been borrowed almost verbatim from Rasarnava.)

Or, enclosed in a crucible with borax and the juice of lemons and strongly heated, it yields an essence in the shape of copper 135

Pure blue vitriol, of the colour of pea-cock, in combination with the aforesaid drugs and by the application of various processes, gives up its essence 136

CHAPALA

There are four varieties of it—yellow, white, red and black. That which has the lustre of gold or silver is most

appropriate for the fixation of mercury. The last two are indifferent and readily melt like lac and are useless. *Chapala* melts like tin when heated over fire—hence the name. 143-144

Chapala has six faces and the lustre of a crystal. 146

(*Chapala* is possibly a sulphidic mineral ; its radical meaning is mobile or fickle, hence it is a name often given to quicksilver.)

(Slokas 143-146 are evidently borrowed with slight modifications from Rasarnava ; see p. 137.)

Rasaka

Rasaka (calamine) is of two kinds · the one of laminated structure is known as *dardura*, the other non-laminated is called *karavellaka* 149

Calamine is to be heated and plunged seven times into the juice expressed from the seeds of lemon, or immersed in the urine of man or of horse, or in sour gruel or sour milk, and thus purified. 154-155

(Slokas 149, 154-155 are borrowed from Rasaprakasasudhakara of Yosadhara ; see p. 153)

Extraction of Zinc :—Rub calamine with turmeric, the chebulic myrobalans, resin, the salts, soot, borax, and one-fourth its weight of *Semicarpus anacardium*, and the acid juices. Smear the inside of a tubular crucible with the above mixture and dry it in the sun and close its mouth with another inverted over it, and apply heat ; when the flame issuing from the molten calamine changes from blue to white, the crucible is caught hold of by means of a pair of tongs and its mouth held downwards and it is thrown on the ground, care being taken not to break its tubular end. The essence possessing the lustre of tin, which is dropped, is collected for use. 157-161

(The flame of bluish tint issuing from the mouth of the crucible indicates the combustion of carbon monoxide, so often observed in metallurgical operations. This agrees almost word

for word with what is given in Rasaprakasasudhakara of Yosodhara)

Calamine is to be powdered with lac, treacle, white mustard, the myrobalans, natron and borax, and the mixture boiled with milk and clarified butter and made into balls These are to be enclosed in a crucible and strongly heated. The contents are then poured on a slab of stone—the essence of calamine of the beautiful appearance of tin (thus obtained) is to be used 163-164

Or, a vessel filled with water is to be placed inside a *koshthi* apparatus and a perforated cup or saucer placed over it, a crucible charged as above is to be fixed in an inverted position over the saucer and strongly heated by means of the fire of *jujube* (*Zizyphus jujuba*) charcoal. the essence which drops into the water should be applied in medicine 165-166

(This is a case of distillation *per descensum.*)

This essence is to be mixed with orpiment and thrown over an earthen dish and rubbed with an iron rod till it is reduced to ashes (Obviously the operation is to be performed over fire.) 167-168

Book III

The Uparasas or Inferior Rasas

Sulphur, red ochre, vitriol, alum, orpiment, realgar, *anjana* and *kamkushtha*—these are eight *uparasas*, useful in operations of mercury. 1

(Then follows the mythical origin of sulphur.)

* * * *

Sulphur

Sulphur is of three kinds: that of the first quality resembles the beak of a parrot; that of the second quality is yellow; whereas the white variety is the worst. Another au-

thority says · there are four kinds of sulphur according as it is of white, yellow, red and black colour respectively ·· the black variety is rare. 12-15

Melted sulphur is poured into the juice of *Verbesina calendulacea* and thus purified.

A vessel which contains milk has its mouth tied down with a piece of cloth, over which is deposited finely powdered sulphur; the latter again covered with an earthen bowl. Heat is applied from above by burning cow-dung cakes. The melted sulphur drops into the milk and is thus purified.

24-25

GAIRIKA

Gairika (red ochre) is of two kinds. the one, *pashana gairika*, is hard and copper-coloured; the other is *swarna gairika*, i.e. of the colour of gold (yellow). 46

KASISA

Kasisa (sulphate of iron) is of two kinds. *valuka-kasisa* and *pushpa-kasisa*. (The former, termed in other works *dhatukasisa*, is the green variety and the latter, the basic or yellowish variety.) 51

Its essence is to be extracted like that of alum. 54

TUVARI

Tuvari (alum). the fragrant earth produced in the mountains of Surat is known as *tuvari*, which dyes cloth and fixes the colour of maddar. 59

A second variety of it, called *phataki* or *phullika*, is slightly yellow. Another variety, known as *phulla tuvari*, is white and acid in taste; iron changes to copper by the process of *lepa*. (The author seems to convey the idea that alum plays an

important part in this process. *Lepa* is used in the sense of transmutation of the baser metals.) 60-62

Alum is astringent, acid, beneficial to the eye and killer of mercury.

Alum is to be macerated in the bile of the ox one-hundred times and then its essence is to be extracted by distillation— a very secret process, not to be divulged. 65

Talaka

Talaka (orpiment) is of two kinds · the one is of a leafy structure, the other is found in balls or cakes and is of golden colour . . . . and bright. 66

It is purified by being digested in the juice of cucumber and the alkaline water of the ashes of sesamum, or in lime water. 69

Talaka is to be rubbed with buffalo's urine and thrice macerated in the decoction of *Butea monosperma* of the consistency of honey, and then to be roasted in a covered crucible and powdered. This operation is to be repeated twelve times. It is then fit to be used in medicines. (Most likely a sulpharsenite of potash is formed in the process) 74-75

Take one pala of *talaka* and rub it for one day with the milky juice of *Calotropis gigantea*, and mix it with the same weight of oil and heat it in an open place for seven days and nights together. Collect the white essence when it is cooled down 80-81

Manassila

Manassila (realgar) is mixed with one-eighth part of its weight of iron-rust, molasses, bdellium and clarified butter, and then enclosed in the *koshthi* apparatus and strongly heated, when it yields its essence. 95

THE ANJANAS

The *Anjanas* (collyriums).—Of these there are *sauviranjana, rasanjana, srotonjana, pushpanjana* and *nilanjana*; their properties are described below. 97-98

Nilanjana is a *killer* of gold (*cf.* the *killing* of gold, silver, iron and copper in Vagbhata, p. 71) and induces softness in iron, i e. renders it easily pulverizable. (This is due to the fact that iron becomes impregnated with brittle sulphide of iron.) 104

The essence of the anjanas is to be extracted like that of realgar.

(These five varieties of *anjanas* are used as cosmetics for the eyes. *Anjana* literally means collyrium or medicine for the eyes. *Sauviranjana* is mostly galena or sulphide of lead, though it is usually translated as sulphide of antimony. It is said to be obtained from the mountains of Sauvira, a country along the Indus, whence it derives its name.)

Srotonjana is evidently stibnite or the native sulphide of antimony The word literally means 'produced from a river', especially from the Yamuna.

Nilanjana is undoubtedly stibnite or antimony sulphide.

Pushpanjana is described as an alkaline substance. It is rather unidentifiable.

Rasanjana is the extract of the wood of *Berberis asiatica*

Kamkushtham is produced at the foot of the Himalayas . . . . Some are of opinion that it is the excrement of a new born elephant..... it is of white and yellow colour, and is a strong purgative. 109-112

THE COMMON RASAS

Kampilla, chapala, gauripashana, navasaraka, kaparda, agnijara, hingula, girisindura. mriddarasringakam, ; these are

the eight common *rasas* regarded as useful adjuncts to chemical operations by Nagarjuna and other experts. 120-121

Kampilla is like brick-dust. ..a purgative. ..a natural product of Surat....and a vermifuge (It is not clear, what *kampilla* denotes)

Gauripashana is of the lustre of rock-crystal, conch and turmeric respectively.....its white essence is to be extracted like that of orpiment. (This also cannot be identified.) 124-125

NAVASARA AND OTHER RASAS

Navasara (sal-ammoniac is produced by the decomposition of the shoots of bamboos and of the wood of *Careya arborea*; *navasara* is an alkali, its another name is *chulikalavana* (lit. salt deposited in the hearth); it is produced during the burning of the brick....it kills mercury, liquefies iron, is a stomachic, an absorbent of the spleen, and aids digestion after much eating. 127-129

(Sal-ammoniac cannot, however, be an alkali; a confusion of salts with alkalies.)

Varataka (cowrie or marine shell).—Alchemists prefer shells which are of yellow colour, knotty and possessed of circular lines on the dorsal side...... macerated for three hours in sour gruel, it undergoes purification. 130-134

Agnijara is a substance discharged from the womb of a kind of sea-crocodile and dried in the sun. (This cannot be identified.) 135

Girisindura (lit. vermilion derived from the rocks) occurs along the big mountains (inside the rocks.) 137

Hingula (cinnabar, syn. *darada*)·—Quicksilver extracted from it is as efficacious as killed- sulphur. When darada is placed in a retort and its essence collected in water, it yields the same substance as quicksilver—of this there is no doubt. 141-144

Mriddarasringakam :—It is yellow and of leafy structure and occurs in Gujerat and round about mount Abu. 145

(It is not possible to make out what is meant by this name).

Rajavarta (lapis lazuli) has a bluish tint but with slight admixture of red .... it is killed by being powdered in combination with lemon-juice and sulphur, and roasted seven times in a covered crucible. 149-153

Book IV

The Gems

The gems also are regarded as agencies which help the fixation or coagulation of mercury. These are the gems :— *Vaikranta*, *suryakanta* (sun-stone), *hirakam* (diamond), *mauktikam* (pearls), *chandrakanta* (moonstone), *rajavarta* (lapis lazuli) and *garudodgara* (the emerald, lit. derived from the vomit of Garuda); the topaz, the sapphire, the coral, the cat's eye are also reckoned among the gems. These are to be carefully collected for fixation of mercury. 1-3

(The ruby and the zircon are also mentioned. The *vaikranta* is a kind of gem, said to resemble diamond and to be of similar properties. Gems and jewels are mentioned in the earliest writings of the Hindus; and precious stones play a prominent part in their mythologies, traditions, legends and poems.)

Vajram

Vajram (diamond) is of three kinds: male, female and hermaphrodite. Its medicinal properties vary in excellence in the order in which they have been spoken. 26

The one with eight angles and eight faces and six corners, very brilliant, with the play of rainbow colours (indicating high refraction and dispersion), is known as the male diamond; whereas the female diamond is flattened and rounded; whilst the neuter is rounded, obtuse-angled and slightly heavy. 27-28

Each of these again is divided into four classes, according to its colour; namely, *brahmana*, *kshatriya*, *vaisya* and *sudra*. 30

("Diamonds, white like the conch, water-lily or crystal, are *brahmanas*; those, which are red like the eyes of the hare, are *kshatriyas*; those, which are verdant like the cool plantain leaf, are *vaisyas*, those, which resemble in colour the clean sword, are known as *sudras*"—*Manimala*, a treaties on gems, by S. M. Tagore, p. 100.)

Diamond is a bestower of long life, a tonic, an allayer of the three derangements (namely, of air, phlegm and bile), a killer of all the ailments, a fixer of mercury, a subduer of death—in short it is like nectar. 32

Diamond is digested in the decoction of *kulattha* (*Dolichos biflorus*) or of *kodrava* (*Paspalum scrobiculatum*) for three hours and thus purified. Diamond is to be macerated four times in the blood of the bug and enclosed in a ball made of the flesh of the musk-rat, and then to be roasted in a covered crucible thirty times, or to be heated hundred times and plunged in the decoction of *kulattha*. 34-37

Diamond is to be placed in a covered crucible, the inside of which has been coated with realgar, rubbed with the decoction of *kulattha* and the juice of *Artocarpus lakoocha* and roasted eight times in succession in the fire of dry cow-dung cakes. It is then heated hundred times and thrown into pure mercury—the diamond is thus killed and reduced to fine ashes. 38-39

The veracious alchemist Somasenani, after having convinced himself of the success of this process by his own experiments, has given it to the world. 40

Diamond is to be smeared seven times in the blood of the bug and dried in the sun, and then to be placed in an iron pot and filled with the juice of *Cassia sophera*, and heated seven times. The diamond is sure to be reduced to ashes This process has been described by the sage, Brahmajyoti. 41-42

Diamond smeared with the powder of lead, levigated in the juice of the fruit of *madana* (*Randia dumetorum*) and roasted twenty times in a covered crucible, is reduced to fine powder, which is to be used in medicines. 44-45

General Process of reducing Gems to Ashes

All the gems with the exception of diamond are killed when roasted eight times with a mixture of realgar, sulphur and orpiment, rubbed in the juice of *Artocarpus lakoocha*. 63

Take asafoetida, the five salts, the three alkalies, *Rumex vesicarius*, sal-ammoniac, the ripe fruit of the croton plant, *jalamukhi* (*Anthericum tuberosum*), *rudanti* (*Asclepias rosea*), the root of *Plumbago zeylanica*, and the milky juice of *Euphorbia antiquorum* and *Calotropis gigantea*—rub all these together and make them into a ball Place inside it the noble and luck-yielding gems Wrap the ball with the leaves of *Betula bhojpattra* and tie them with thread, and enclose the ball again in a piece of cloth, and suspend it in a *dola yantra* filled with the acids and sour gruel, and apply strong heat for three days and nights—the liquid principle of the gems is thus collected. 64-69

Powdered pearl is to be rubbed with the juice of *Rumex vesicarius*, and then transferred inside a lemon and stowed in a mass of paddy. At the end of a week it is heated in a crucible and liquefied. 70-71

Diamond, placed inside the stem of *Vitis quadrangularis* and heated four weeks in acids, is liquefied. 72

Vaikranta, which is of white colour, liquefies when macerated in the juice of *Rumex vesicarius* and exposed to the sun for a week. 73

Take the juice of *Pandanus odoratissimuss*, rock-salt, *svarna pushpika*, together with coccinella insect : *vaikranta* melts on being digested in this concoction for a week. 74

Book V

On Metals (*Loham*)

The pure metals are gold, silver and iron. The *putilohas* (lit. metals emitting a foetid odour) are two . lead and tin. *Dhatuloham* is iron proper and often conveys different meanings. The alloys are three in number brass, bell-metal, and *vartaloha*. 1

Gold

Gold is known to be of five kinds, of which three are attributed to mythical and celestial origin , the fourth is called *khanija* (lit begot of mines) . the fifth is obtained by the transmutation of the baser metals 2

Gold is to be purified and killed, as otherwise (if taken internally) it robs one of strength, virility and happiness, and brings a series of maladies. 11

Gold-leaf of the weight of one *karsha* is to be smeared with salt and placed between two earthen saucers and heated on a charcoal fire for an hour and a half, when its true colours will come out. 12

The best method of killing all the metals is with the aid of the ashes of mercury (generally sulphide of mercury). The next best is through the agency of the roots, whereas *killing* with sulphur is least to be recommended. 13

When a metal is *killed* with *ariloha* (meaning, not clear), it is injurious. Gold-leaves, pierced with holes and coated with a paste of lemon-juice and the ashes of mercury, and roasted ten times, are thereby killed. 14

Project into melted gold its own weight of the ash of mercury , (when cooled) powder it and rub it with lemon-juice and cinnabar, and roast it in a covered crucible twelve times The gold thus acquires the colour of saffron. 15-16

Gold-leaf is *killed* by being rubbed with one-fourth of its own weight of *killed* mercury and acid of any kind, and roasted eight times. 17

In this process gold is, in reality, converted into the sulphide (sulphur comes from *killed* mercury which is sulphide of mercury), and afterwards into metallic gold in a fine state of powder.

SILVER

Silver is of three kinds: namely *sahajam* (of mythical origin), begotten of mines, and artificial. 22

Silver melted with lead and borax undergoes purification Arrange on an earthen dish a mixture of lime and ashes in a circular row and place in it silver with its equal weight of lead. Now roast it over fire until the lead is consumed Silver thus purified is to be used for medicinal purposes. 32-34

(The process is practically that of cupellation).

Silver-leaf is to be rubbed with mercury and the juice of *Artocarpus lakoocha* and is to be embedded in sulphur and heated in a covered crucible over a sand-bath; when cold, the mass is once more rubbed with orpiment and acids and roasted twelve times. By this process, the silver is reduced to ashes 35-37

Silver is reduced to ashes by being three times rubbed with powdered iron pyrites and lemon-juice, and roasted in a covered crucible. 38

Take four parts of silver-leaf and one of orpiment, rub them with the juice of lemon, and roast the mixture and repeat the operation fourteen times, and thus silver is completely incinerated.

In the processes described above silver is converted into its sulphide.

Copper

There are two varieties of copper: the one brought from Nepal is of superior quality; that dug out of mines of other countries is designated *mlechchha* 44

(Mlechchha is a generic name for a barbarian or a foreigner)

Copper-leaf is killed by being rubbed with lemon-juice, sulphur and mercury and roasted thrice (sulphide of copper). 55

Iron

There are three kinds of iron: namely, *mundam* (wrought iron), *tikshnam* and *kantam*, *mundam* again is of three varieties: viz *mridu*, *kuntham* and *kadaram*. 70

That, which easily melts, does not break and is glossy, is *mridu*; that, which expands with difficulty when struck with a hammer, is known as *kuntham*, that, which breaks when struck with a hammer and has a black fracture, is *kadaram*. 71-72

Tikshnam (cast iron, steel):—There are six varieties of it One variety is rough and free from hair-like lines and has a quicksilver-like fracture and breaks when bent Another variety breaks with difficulty and presents a sharp edge 75-78

Kantam —There are five kinds of it, namely, *bhramaka*, *chumbaka*, *karshaka*, *dravaka* and *romakanta* It possesses one, two, three, four and five faces and often many faces (with which to attract iron) and is of yellow, black and red colour respectively. The variety, which makes all kinds of iron move about, is called *bhramaka*; that which kisses iron is called *chumbaka*; that which attracts iron is called *karshaka*; that which at once melts the iron is called *dravaka* (lit. a solvent); and the fifth kind is that which, when broken, shoots forth hair-like filaments. 84-89

Mercury is like an intoxicated elephant and *kantam* is like the bent hook wherewith to restrain it. The wise man

digs it out of the mines. That which has remained exposed to the sun and the atmosphere is to be avoided. 92-93

(Couplets 84-93 are taken bodily from Rasarnava.)

If water is kept in a vessel and oil poured over it, and the oil does not spread about; if asafoetida gives up its odour, and decoction of *neem* (*Azadirachta indica*) its bitterness, and milk, being boiled in it, does not overflow but rises high like a peak — if such be the characteristics of the vessel, know that it is made of *kanta* iron. 94

Powdered iron is to be macerated awhile in the decoction of the three myrobalans, in cow's urine, and then to be mixed up with clarified butter and fried in an earthen vessel and stirred with an iron rod until a blade of straw, thrown over it, catches fire. The iron powder is to be pounded and the above process repeated five times. Or, iron is roasted four times in a covered crucible with the decoction of the myrobalans and is reduced to fine powder. 104-105

(The process is practically identical with that described by Chakrapani.)

Leaves of *tikshna* iron are repeatedly to be heated and plunged into water and then to be powdered in a stone mortar with an iron pestle * * * . The powder of iron thus obtained is to be roasted twenty times in a covered crucible in combination with mercury and sulphur, and after each roasting the powder of iron is to be pounded as directed above—iron thus reduced to ashes is to be used in medicine. 107-110

Take one part of iron and twentieth part of its weight of cinnabar, rub them with lemon-juice and sour gruel, and roast the mixture in a covered crucible. The operation being repeated forty times, *kantam, tikshnam* and *mundam* are killed, —of this there is no doubt. 113-114

Take one part of mercury, sulphur two parts and iron powder three parts, and rub them with the juice of the Indian aloe, and after six hours transfer the mass to a brass vessel and cover it with the leaves of the castor-oil plant. At the

end of an hour and a half the mass will become heated It is then buried under a heap of paddy grains and taken out after three days and then powdered very fine, and the contents passed through linen. All the three varieties of iron are thus completely killed Gold and other metals can be killed by this process after being reduced to fine powder like iron. 134-137

Rust of iron is to be heated and powdered till it is reduced to fine powder—this is called *mandura*. 147

The qualities which reside in killed iron are also to be found in the rust of iron, hence the latter may be substituted for the treatment of diseases.

Tin

Vangam (tin) is of two kinds—*kshurakam* and *misrakam*, the former is endowed with superior qualities; the latter cannot be recommended for medicinal uses. 153.

Kshurakam is white, soft, cool (to the touch), readily fusible and bright, and does not clink (when bent or struck). 154

Misrakam is dirty white * * *. This is an anthelmintic and a destroyer of urinary disorders. 155

Molten tin is dropped into the juice of *Vitex negundo* mixed with turmeric, the process being repeated three times the metal undergoes purification. 156

Tin-foil is to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea*, and then to be covered with the ashes of the bark of *Ficus bengalensis* and *Tamarindus indica* and afterwards roasted and reduced to ashes.

Lead

Sisakam is readily fusible, very heavy, presents a black and bright appearance on fracture, is of foetid odour and black exterior. 171

Take twenty palas of lead and apply strong heat to it, and drop into the molten metal one *karsha* of mercury and throw into it one after another the ashes of *Terminalia arjuna, Terminalia belerica,* pomegranate and *Achyranthes arpera,* weighing one pala each. The mass being vigorously stirred with an iron spoon for twenty nights in succession, the metal is calcined yielding a bright red ash. 176-179

Leaves of lead are to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and roasted in a covered crucible till the metal is entirely killed. 184

BRASS, BELL-METAL, ETC.

Pittala (brass) is of two kinds—*ritika* and *kakatundi*; the former on being heated and plunged into sour gruel turns copper-coloured. 192-193

Brass, which is heavy, soft, of yellow colour, capable of resisting strokes, is to be recommended. 195

Brass, which is light and of offensive odour, is not good for medicinal purposes.

Brass, smeared with a paste of lemon-juice, orpiment and sulphur and roasted eight times, is reduced to ashes. The process of killing brass is the same as that of copper.

201-202

Kamsya (bell-metal) is made by melting together eight parts of copper and two parts of tin. 205

It is completly killed by being roasted five times with sulphur and orpiment. 210

Vartaloham is produced from *kamsya,* copper, *pittala,* iron and lead; hence it is regarded by metallurgists as an alloy of five metals... It is killed with the aid of sulphur and orpiment. 212-216

Book VI

Initiation into Discipleship

(This chapter is full of directions for the mystic Tantric rites, after the performance of which the pupil is to be initiated into the secrets of mercurial lore.)

The instructor must be wise, experienced, well-versed in chemical processes, devoted to Siva and his consort Parvati, sober and patient. The pupil should be full of reverence for his teacher, well-behaved, truthful, hard-working, obedient, free from pride and conceit, and strong in faith. 3-7

Chemical operations are to be performed under the auspices of a ruler, who is god-fearing, who worships Siva and Parvati, and whose territory is free from anarchy; and the laboratory, to be erected in the depth of a forest garden, should be spacious, furnished with four doors and adorned with the portraits of the gods 13-15

Take a gold-leaf three *niskas* in weight and quicksilver nine *niskas* and rub them with acids for three hours Make the amalgam into a phallus (emblem of Siva, the creative principle) .... the phallus to be worshipped in due form. By the mere sight of the phallus of mercury, the sins accumulated by the killing of 1,000 brahmins and 10,000 cows are redeemed. 19-22

The science of mercury was communicated by Siva himself and is to be imparted by the instructor to the disciple according to the prescribed rules with closed eyes. 30

The apparatus and implements, as also the ingredients, required for chemical operations, are also to be addressed in prayer. . and the names of the twenty-seven alchemists to be invoked 53-61

The science of mercury is to be strictly kept a secret . . . if it is divulged, its efficacy is gone 70

Book VII

On the Laboratory

The laboratory is to be erected in a region, which abounds in medicinal herbs and wells. . . it is to be furnished with various apparatuses. The phallus of mercury is to be placed in the east, furnaces to be arranged in the south-east, instruments south-west; washing operations in the west; drying in the north-west. . . . The *koshthi* apparatus for the extraction of essences, the water vessels, a pair of bellows and various other instruments are also to be collected ; as also the thrashing and pounding mortars, the pestles, sieves of various degrees of fineness, earth for the crucibles, dried cow-dung cake, retorts made of glass, earth, iron and conch-shells, iron pans, etc.
1-18

Those who are truthful, free from temptations, given to worship of *devas* and brahmins, self-controlled and used to live upon proper diet and regimen—such are to be engaged in performing chemical operations. 30

Such herbalists, as are not deceitful and are well-versed in the knowledge of the drugs and plants and in the language of many countries, should be employed. 32

Book VIII

On Technical Terms

(This chapter is mostly a reproduction from Rasendrachudamani of Somadeva ; see p. 151.)

For the comprehension of ignorant physicians, Somadeva is now expounding the technicalities as made use of by experts. 1

The physician is entitled to half the share of prepared mercury, and eighth part of medicated oils and ghee, and seventh part of prepared iron and other metals. 2

Mercury, on being finely rubbed with melted sulphur and other minerals, attains the tint of collyrium and is called *kajjali*, which again on being rubbed with a liquid substance is known as *rasapanka* (lit. mud of mercury). 5-6

Tests for Killed Iron

Killed iron is that which in the shape of impalpable powder floats on water and, when rubbed between the thumb and the fore-finger, enters the lines; which, on being mixed with treacle, *Abrus precatorius*, honey and ghee, and heated, does not revert to the natural state; which floats on water like duck and does not sink down even when heavy things like paddy grains are placed over it. 25-28

Couplet 29, giving test for killed iron, and couplet 38, describing the extraction of antimony from stibnite, have already been reproduced before under Rasendrachudamani (see p 151).

Certain other Technical Terms

The resurrection of the dead (the conversion of killed iron into the metallic state) is known as *Utthapana* (lit raising).

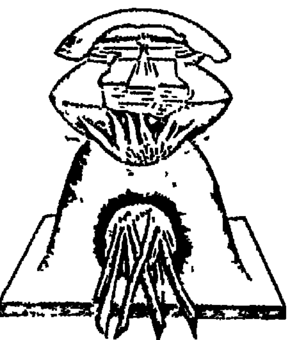
39

The capacity of mercury to swallow food (i e. to combine with certain substances or to take up the qualities inherent in them) is known as *grasamanam*. 64

Mercury, alloyed with one-sixtyfourth part of its weight of gold or silver, acquires a mouth wherewith to swallow even hard metals 68-69

Lepa, *kshepa*, and *kunta* signify *dhuma* i.e. smoke. By the process of *lepa* is meant the conversion of iron into gold or silver. 80

The conversion of iron into gold or silver with the aid of mercury thrown into a smoky flame, emitting vapour, is known as *dhumavedhi* (lit. pierced by smoke). 83



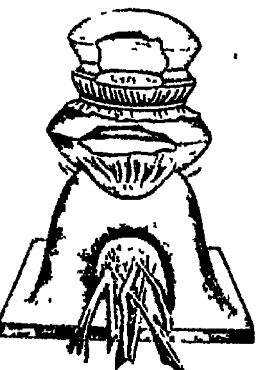


Fig. 30c

Dola yantram.

Svedam yantram.

Page 189

The conversion of a small quantity of a metal into gold through the agency of mercury.....which has acquired a mouth, is called *sabdavedha*. 84

Somadeva collected these brilliant gems of technical terms with great care from the ocean of mercurial lore and strung them into a necklace which adorns the best of physicians in assemblies. 89

Book IX

On Apparatus (*Yantras*)

(This chapter also is evidently quoted from the work of Somadeva.)

Somadeva will now give a brief account of the apparatuses after having considered innumerable works on chemistry. 1

Dola Yantram :—A pot is half-filled with a liquid and a rod placed across its mouth from which is suspended the medicine tied in a piece of cloth. The liquid is allowed to boil and a second pot inverted over the first (*cf.* Rasarnava, p. 135 and see Fig. 30 C). 3-4

Svedani Yantram :—A pot with boiling water has its mouth covered with a piece of cloth and the substance to be steamed is placed on it, and a second pot is arranged in an inverted position over the rim of the first (Fig. 30 C). 5

Patana Yantram (lit. apparatus for sublimation and distillation) :—Two vessels are adjusted so that the neck of the one fits into that of the other. The junction of the necks is luted with a composition made of lime, raw sugar, rust of iron, and buffalo's milk (*cf. Dipika Yantram* of Rasahridaya, p 147). 6-8

Adhaspatana Yantram :—A modification of the above apparatus in which the bottom of the upper vessel is smeared with the substance, the vapour or essence thereof condensing into the water of the lower one. Heat is applied on the top

of the upper vessel by means of the fire of dried cow-dung cakes (Fig. 30 B). 9

Dheki Yantram.—Below the neck of the pot is a hole into which is introduced the upper end of a bamboo tube, the lower end of it fitting into a brass vessel filled with water and made of two hemispherical halves Mercury mixed with the proper ingredients is subjected to distillation till the receiver gets sufficiently heated (Fig. 30 D). 11-14

Valuka Yantram (sand-bath) :—A glass flask with a long neck containing mercurials is wrapped with several folds of cloth smeared with clay, and then dried in the sun The flask is buried up to three-fourths of its length in sand placed in an earthen pot, whilst another pot is inverted over it, the rims of both being luted with clay. Heat is now applied till a straw placed on its top gets burnt (Fig. 30 D). 34-36

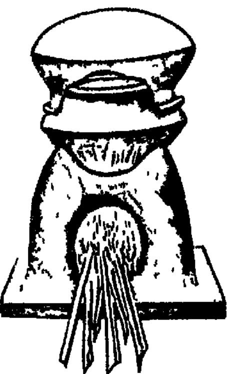
Lavana Yantram :—If in the above apparatus salt is substituted for sand, it is called lavana yantram (salt-bath) 38

Nalika Yantram —If in the above an iron tube be substituted for the glass flask, it is called nalika yantram. 41

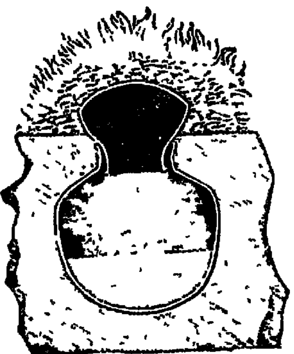
Place the crucible containing chemicals inside a mass of sand and apply heat by means of cow-dung cakes. This is known as the *Bhudhara Yantram.*

Tiryakpatana Yantram (lit. distillation *per descensum*).—Place the chemicals in a vessel provided with a long tube, inserted in an inclined position, which enters the interior of another vessel arranged as receiver. The mouths of the vessels and the joints should be luted with clay Now urge a strong fire at the bottom of the vessel containing the chemicals, whilst in the other vessel place cold water. This (process) is known as *tiryakpatanam* (Fig. 30 E). 48-50

Vidyadhara Yantram :—Vidyadhara yantram is for the extraction of mercury from cinnabar. Two earthen pots are arranged one above the other. Place cold water in the upper vessel and heat the lower one by burning fire from below.



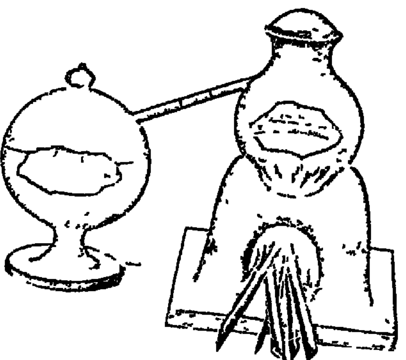
Patana yantram.



Adhaspatana yantram

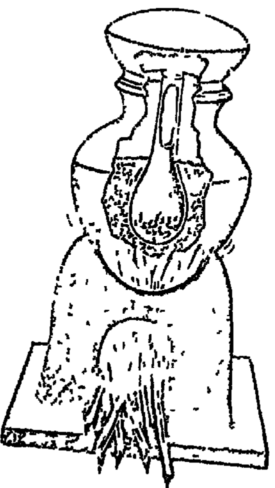
Fig. 30b.

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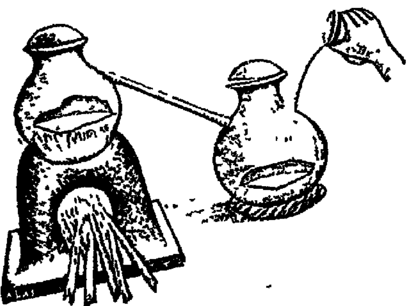
Dheki yantram

Fig 30*d*.

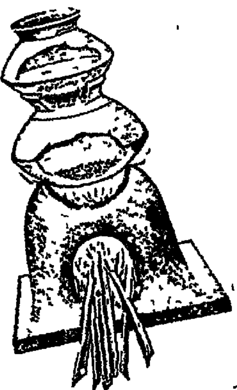


Valuka yantram.

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Tiryakpatana yantram.



Vidyadhara yantram.

Fig. 30e.

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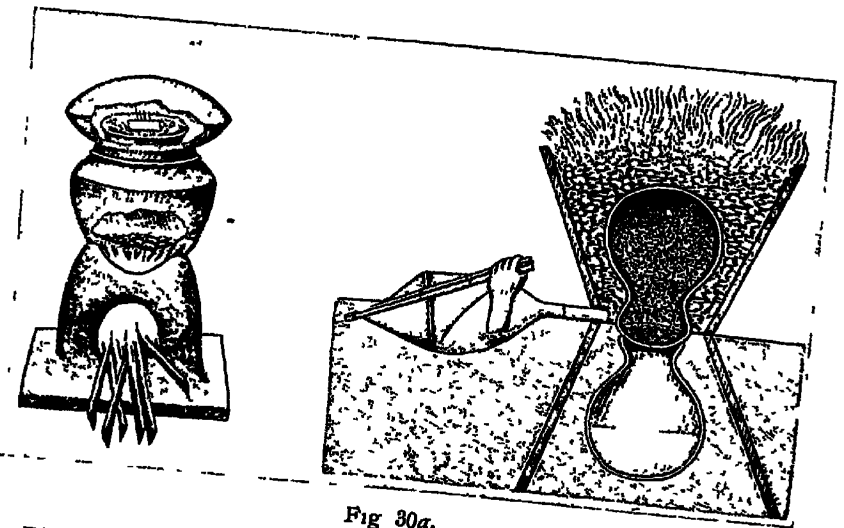


Fig 30a.

Dhupa yantram

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Koshthi apparatus

Page 172

Cinnabar is placed in the lower vessel, and mercury condenses at the bottom of the upper vessel (Fig. 30 E). 57-58

Dhupa Yantram (lit. fumigating apparatus) :—Bars of iron are laid in a slanting position a little below the mouth of the lower vessel and gold-leaves are placed over them, and at the bottom of the vessel is deposited a mixture of sulphur, realgar, orpiment, etc. A second vessel, with its convexity turned upwards, covers the mouth of the lower one, and the rims are luted with clay. Heat is now applied from below. This is called fumigation of gold-leaves. Silver may also be similarly treated (Fig 30 A). 70-74

This chapter concludes with a detailed description of mortars and pestles—their sizes, measurements, etc.

Book X

On the Ingredients for Crucibles, etc.

Earth which is heavy and of a pale colour, sugar or earth from an ant-hill, or earth which has been mixed with the burnt husks of paddy, fibres of the hemp plant, charcoal and horse-dung pounded in an iron mortar, and also rust of iron, are to be recommended for crucible-making. 5-6

Vrintaka Crucible :—A crucible of the shape of the brinjal (*Solanum melongena*) to which is attached a tubular end, expanding towards its mouth like the flower of *Datura stramonium*, and which is either twelve or eight digits in length, is suitable for the extraction of the essence of calamine and other readily fusible minerals. 23-24

Then follows a long account of the different kinds of crucibles to be used for different chemical operations.

Calcination, Roasting, etc :—When metals have undergone roasting they cannot be roasted to their former condition (i e. they lose their own properties) and they acquire superior qualities, fill up the lines in the fingers and do not sink in water. 51

A quadrangular pit, two cubits in length, breadth and depth respectively, is filled with 1,000 cow-dung cakes. The drugs to be roasted are placed in one crucible; this is covered with a second, the rims being luted with clay. The crucibles are deposited over the cow-dung cakes and five hundred more thrown over them: fire is now applied. 54-55

The Metals :—The six metals are: gold, silver, copper, tin, lead and iron. Kamsya and pittala are artificially made (i e. alloys). 70

The Salts :—The six salts are: *samudram* (lit. derived from the evaporation of sea-water); *saindhava* (or rock-salt); *vidam*, *sauvarchala*, *romaka* and *chulika lavana* (sal-ammoniac).

The Alkalies :—The three alkalies are: carbonate of potash, carbonate of soda (trona or natron) and borax. 71

The Oils :—A list of plants is given from the seeds of which oil is pressed. 73-75

The Fats :—The fats of the jackal, the frog, the tortoise, the crab, the dolphin, the ox, the pig, man and also of the goat, the camel, the ass, the sheep, and the buffalo are to be used. 76-77

The Urines :—The urines of the elephant, the she-buffalo, the ass and the horse are to be used.

The Acids :—The acids are: *Rumex vesicarius*, the citrons and lemons, *Oxalis corniculata*, tamarind, the acid exudation of *Cicer arietinum*, *Zizyphus jujuba*, pomegranate, *Averrhoa carambola*—these are the acids well-suited for the purification, dissolution and killing of mercury and the minerals 80-84

The Earths :—Brick, red ochre, saline deposits, ashes, earth from ant-hills—these five kinds of earth are recommended by the experts. 85

The Poisons :—*Kalakuta*, *Aconitum ferox*, *sringika* and the biles of animals are the chief poisons. 86

The minor poisons are :—*Gloriosa superba, Strychnos nux-vomica, Nerium odorum, Anacardium semicarpus, Datura stramonium, Calotropis gigantea*

(The information on the poisons is most elaborate in the Susruta from which the author has evidently borrowed)

The Solvents :—Treacle, bdellium, *Abrus precatorius*, clarified butter, honey, borax—these are used for helping the fusion of the most infusible metals and hence they are classed among the solvents. 100

Book XI

On the Purification of Mercury

I am now going to describe the various processes for the purification of mercury after having consulted Rasarnava and other works. 10

There are three natural impurities in quicksilver, *visha* (poison), *vanhi* (fire) and *mala* (dirt, dregs), and two artificial, due to its being alloyed with lead and tin. 14-15

[In Rasendrachintamani also we find ; "Trades-people fraudulently adulterate quicksilver with lead and tin, hence it is to be freed from these artificial defects or impurities by means of three distillations".]

Hence for the purification of mercury, the operations (named below) are to be undertaken with the aid of appliances and skilled assistants. 20

On an auspicious day and under the influence of a benign star, a quantity of mercury weighing 2000 or 1000 or 100 or 18 or 10 *palas* is to be taken and the operation begun. 21-22

Patanavidhi .—Purification of mercury by distillation. 33

Fixation of Mercury

Rasavandha :—Processes for destroying the fluidity of mercury :-

Take mercury and one-fourth its weight of *killed* gold and with the addition of sulphur make a ball. Now add an equal weight of sulphur and roast the mass in a covered crucible. 72

The mercury thus treated is afterwards killed with six times its weight of sulphur. 73

[The shining reddish-brown crystalline sublimate of sulphide of mercury thus obtained is a favourite and frequently used remedy with the Hindu physicians It is reputed to be a panacea for a variety of ills that human flesh is heir to. In the Rasendrachintamani and Rasendrasarasamgraha and other treatises, this preparation is described as *makaradhvaja* and *rasasindura* (lit. minium like mercury). From the supposed presence of gold it is often named *svarnasindura* (lit gold and vermilion). During sublimation, the gold, of course, is left behind. The general belief is that by association with gold the mercury acquires the most potent efficacy. A later work, Rasapradipa, is sceptical about the part which gold plays and recommends its being left out.]

Incineration of Mercury

(The chapter concludes with certain recipes for the *killing* of mercury, with the aid of purely vegetable products)

Mercury, roasted in a covered crucible with asafoetida, which has been previously digested in the milky juice of *Ficus oppositifolia*, is reduced to ashes 111

Andropogon serratus and *Clitoria ternatea* are to be pounded in a mortar with sour gruel and with the paste thus formed, mercury is to be triturated and digested seven times and finally roasted in a covered crucible after addition of fresh quantities of the above paste. The mercury is reduced to ashes, resembling salt. 112-113

The seeds of *Achyranthes aspera* and *Ricinus communis* are to be pounded together The mercury is to be placed in-

side the powder and the mass roasted as before. The mercury is reduced to ashes. 114

Purified mercury is to be preserved in the hollow of a horn or tooth or of bamboo. 119

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Here ends Chapter XI of Rasaratnasamuchchaya which treats of the purification, fixation and incineration of mercury.

CHAPTER III

OTHER TREATISES

Chemistry in Rasarajalakshmi of Vishnudeva

It gives an account of common *rasas* and *uparasas*

Chemistry in Rasanakshatramalika of Mathanasimha

There are several prescriptions given in this work in which mineral preparations play a conspicuous part. In the Sanskrit texts two such have been quoted. In the first, among other ingredients, opium occurs; in the second, the Svachchhandabhairavarasa, probably named after the celebrated alchemist, we have the calces of tin, iron and mercury along with other drugs

Chemistry in Rasaratnakara of Nityanatha

Test for killed mercury:—When the substance, being heated over a fire of paddy husks, remains unaltered in weight, it should be considered as reduced to a calx

Purified mercury should be stored in the hollow of a tooth or horn or bamboo

Directions for making factitious cinnabar (*makaradhvaja*) are here given.

Chemistry in Dhaturatnamala

In the beginning the author after salutation says: "I shall speak of silver, gold, copper, lead, tin and iron; as also of calamine, mica, pearls, coral, orpiment, realgar, the pyrites, mercury and diamonds, in fact, the properties of all the metals and minerals and the mode of their incineration"

Directions are given for the *killing* of silver.

Chemistry in Rasapradipa

Description for preparing mineral acids by distillation :—*Samkhadravarasa* or liquid for dissolving conch-shells ; this is to be prepared by distilling a mixture of alum, sal-ammoniac, saltpetre and sulphur. Cowrie-shells and metals dropped into the liquid are at once dissolved.

Preparation of calomel for the treatment of *phirangaroga* (syphilis) with its application.

Chemistry in Dhatukriya or Dhatumanjari
(Rudrayamala Tantra)

Tin, iron and copper are to be classed among the superior metals

In general a metal being alloyed with silver is improved in quality. *Sattvaja* metal (i.e. an alloy of tin and copper) is of middle quality. 12-14

Couplets 39-49 give synonyms of the different metals.

Synonyms of zinc :—*Jasatva, yasadayaka, rupyabhrata* (lit. brother to silver), *charmaka, kharpara, rasaka,* etc. 50-51

Pittala is an alloy of copper and zinc. 63

Kamsyaka is an alloy of tin and copper. 65

Zinc being amalgamated with mercury gives rise to *rasaka.* 68

[N.B.—*Rasaka* and *kharpara* are the names generally applied to the mineral calamine, but here they stand for the metal zinc or its amalgam.]

Lead being *killed* with the aid of gentle heat gives rise to minium (red lead). 69

Copper in combination with the "burning water" gives rise to *tuttha* (blue vitriol). Thus manifold operations are

performed with the aid of *mantras* and apparatus: all these belong to the province of chemistry. 70-71

Synonyms of *haritala* (orpiment):—Orpiment is a consumer of mercury and also a clipper of its wings 79

[Mercury, being rubbed and gently heated with orpiment or sulphide of arsenic, is itself converted into its sulphide. It is thereby *killed* or *fixed*, i.e. loses its volatility or clipped of its wings.]

Synonyms of realgar, cinnabar, mica, etc. are given. 81-89

Synonyms of pearl, coral, tortoise-shell, conch-shell, tusk of elephants, the tail of the peacock are given. 90-108

Commonplace information about the localities of different metals. 113-121

Localities for copper specified:—Nepal, Kamarupa, Bengal, the country of the *mlechchhas*, Ruma and the country of the *phirangas*, etc. 143-145

Localities for zinc—Kamboja, Ruma (Istambul), Balkh etc. 146

Metals in combination with mercury and sulphur become fit for administration as medicine. 153

* * * * *

Process of roasting a substance in a stout glass vessel using goat- and cow-dung cakes and husks of paddy grains as fuel, is described. 9-10

One part of gold and four parts of zinc are to be melted together and the alloy roasted in a closed crucible .....the process repeated with the addition of alkalies... ..gold of a reddish-yellow colour will thus be generated. 11-17

A process for making factitious cinnabar by pouring mercury into its own weight of molten sulphur and then adding three-fourths its weight of orpiment . . . . . The mass is to be rubbed in a mortar and subjected to sublimation. 23-30

By using the augmented (weight increased by the addition of inferior metals) gold as a means of exchange one can amass wealth. 52

Tin is to be melted and one-hundredth part its weight of mercury to be amalgamated with it. This (fraudulent substitute for) silver can be used for purposes of exchange, and one can thus amass wealth. 85-86

Pure gold is to be alloyed with one hundred times its weight of copper and this (imitation) gold will resemble native gold. 88

Lead and copper being alloyed together will give rise to gold. 97-98

Here ends the chapter on the extolling of gold in Rudrayamala.

Chemistry in Suvarnatantra or Svarnatantra

The origin of the Tantra is explained in the opening lines. Parasurama having given away his worldly possessions to Kasyapa is rendered destitute, and thus has to invoke the aid of the god Siva for his very maintenance.

Siva said: Listen! I shall now reveal to you the most wonderful mysteries of Svarnatantra. 1-10

A kind of oil is exuded from the bulbous root of a plant; all around it within a radius of ten cubits oily water is exuded and a venomous snake lives under it. If you want to test the properties of the bulb, you should thrust a needle into it, and the needle at once dissolves. Having procured this bulb, rub it with mercury in a mortar and add the oil and subject the mixture to heat in a crucible. The mercury is at once *killed* and acquires the property of converting one hundred thousand times its own weight of the base metal into gold. 14-18

Pure orpiment is to be rubbed with this oil for 20 days, and the former is *killed* thereby and losses its volatility. The eight

metals in the molten state being treated with this prepared orpiment acquire the power of transmutation. When the above oil is thrown into molten copper, it is turned into gold of beautiful lustre Tin and bell-metal similarly treated are turned into silver; and copper, iron, brass and silver similarly turn into gold. 19-24

Samkhadravaka (aqua regia) is spoken of as universal solvent..... The solvent with mercury is to be placed in a glazed crucible and subjected to heat; the mercury, thus *killed*, can convert the eight metals into gold. By partaking of this mercury one becomes immortal; even his urine and faeces can convert copper into gold 1-10

NOTES ON THE MINERALS, GEMS, SALTS, ETC.

Minerals

Diamond :—Belief in the combustibility of diamond and in its being ***killed*** or reduced to fine ashes, as has been already referred to (*cf.* Rasaratnasamuchchaya, Book IV. The Gems; p. 178), was an accepted creed with the Hindu Iatrochemists.

Vaikranta .—It is described to possess eight faces and six angles and to exhibit a great range of colours. This possibly refers to a mineral crystallizing in the octahedral form, viz., the family of spinels, or to one crystallizing in hexagonal prisms like corrundum. But neither of these minerals are liquefiable as stated in Rasaratnasamuchchaya (The Gems, loc cit.).

Makshikam (pyrites) :—Pyrites is of two kinds : golden and silvery ; FeS_2 is brass yellow in colour, but there are other pyrites-like minerals which are silver-white ; for instance, cobaltite, $CoS_2 . CoAs_2$; lollingite, $FeAs_2$ (S) ; leucopyrite, $Fe_3 As_4$. Copper pyrites has a deep yellow colour.

Gairika .—Haematite, which is red and often hard, and limonite, which is yellow or brown ; both occur in the form of ochres.

Kamkushtham is produced at the foot of the Himalayas. It is of white and yellow colour, and is a strong purgative. Possibly an efflorescence of magnesium sulphate or sodium sulphate ; both are not uncommon. The yellow colour might be due to admixture with ferruginous dirt.

Vajram :—The mention of 8 faces and 6 corners seems to suggest an octahedral crystal of diamond

Gems

Among the sixty-four branches of arts and sciences recognized in the ancient Kamasutra of Vatsayana* (5th century

* A B Keith, *History of Sanskrit Literature*, 1945, p 469.

A D) occur the following : (a) testing of gold and the gems, (b) knowledge of the colouring of gems; as also knowledge of mines and quarries. Varahamihira (6th century A.D) in his Vrihat Samhita, as already stated, conveys much useful informations on the subject, and refers in his turn to experts who preceded him

The Garudapurana (circa 9th century A.D)* under the heading of *Ratnapariksha* (examination of the gems) devotes several chapters to a detailed and exhaustive description of the gems.

From time immemorial the gems have been valued in India not only for purely decorative and ornamental purposes, but also as agents for warding off perils and the malignant influences of the planets, and for securing luck and longevity Hence, particular attention is paid to the testing of gems, as their virtue increases in proportion as they are faultless and flawless.

The typical characters which, according to Garudapurana, are most relied upon for differentiating one species of gem from another are (1) the relative weight, (2) hardness, (3) lustre, transparency and colour, (4) fusibility, specially when heated in combination with alkalies

1. *Relative Weight*.—The principle of Archimedes being evidently unknown among the Hindus, the measurement of volume could only be roughly approximate Thus it is stated that a stone may be of the same species as, and equal in volume to, a *padmaraga* (oriental ruby), but will differ in weight from the latter. Empirical and arbitrary scales of weight were adopted as standards. A ruby occupying the volume of a *gunja* (*Abrus precatorius*) may be equal in weight to 10, 7 and 3 *gunjas* respectively. In each case the gem which is of greater weight is superior in quality, and the value thereof is enhanced in proportion.

* Hazra, *Puranic Records*, 1940

In the case of precious metals, however, adulteration was detected by an ingenious device, which may be regarded as a near approach to the principle of Archimedes, Thus, for testing the purity of gold the following instruction is given by Garuda. A wire of gold to be tested is drawn through the orifice of a corundum. In a similar manner another wire of the standard gold is drawn through the self-same orifice. As these wires are of equal diameters, equal lengths will have equal weights, provided the sample is pure.

2 *Hardness* :—The spurious substitute of any precious stone may easily be detected by its difference in hardness and low specific gravity. The suspected gem may also be rubbed on a whetstone; if it simply gains in lustre but does not lose in weight (by abrasion), the specimen is to be regarded as genuine (test of a ruby). Diamond and corundum alone will scratch ruby and sapphire. All the gems occurring in this world, as also the metals, will be scratched by a diamond, but the latter will not be similarly affected by the former. A diamond alone will scratch a diamond.

3. *Lustre, Transparency, Colour and other Optical Properties* :—Difference in lustre is often regarded as a diagnostic feature of the gems. According to Varaha gems of superior qualities should possess cool (lit. waxy) lustre, be limpid and emit rich rays. Classification according to colour is often enjoined. For instance, a diamond may be perfectly colourless, or it may be yellow, black, red or copper-tinted. Stones which are translucent, opaque and of dull colour are inferior in quality. In the case of diamond special stress is laid on its displaying the colours of the rainbow (due to its high dispersive power). Some gems have only one shade of colour, other again two (dichroism).

The changes in colour, which the ruby and the sapphire undergo under the influence of heat, had evidently been carefully observed. This test is to be applied with extreme caution, as, in case the proper degree of temperature is exceeded, the stone may be materially injured.



readily yield sulphuric acid which, with sodium chloride and nitre, might be expected to produce aqua regia.

Vida or *Vit* (now known as *kalanimak* or 'black salt') :— It is difficult to ascertain what it meant in the Ayurvedic age at the time of the Charaka and the Susruta. An account of the preparation of the black salt is given in Watt's Dictionary of the Economic Products of India.

"Black salt is prepared in upper India chiefly at Bhewani in the Hissar district by heating together in a large earthen pot 82 lb. of common salt, one pound of the fruit of *Terminalia chebula*, and one pound of *Phyllanthus emblica*, and one pound of *sajji* (impure carbonate of soda), until by fusion of the salt the ingredients are well mixed; then the pot is removed from the fire and its contents allowed to cool and form a hard cellular mass. This preparation is used medicinally, principally as digestive"

The salt has a reddish-brown colour and consists mainly of sodium chloride with traces of sodium sulphate, alumina, magnesia, ferric oxide and sulphide of iron. During the fusion, a portion of the sodium sulphate is probably reduced to sulphide by the organic matter (*T. chebula*). This then reacts with the traces of iron salt present to form the sulphide of iron.

Killing of Metals

From the time of the Charaka and the Susruta we find metallic preparations in the shape of oxides, sulphides and sometimes chlorides, recommended for internal administration. The various formulas, which will be found scattered throughout above, give us methods for *killing* metals But a *killed* metal is not necessarily a compound; it sometimes means a metal deprived of its well-characterised physical properties, e g. colour, lustre, etc Thus the Ayurvedic *killed* gold and silver often represent the respective metals in a fine state of division. This is illustrated by the following recipe from Rasaratnakara by Nityanatha :

"Rub gold-leaf with four times its weight of *killed* mercury (i e sulphide of mercury) and sublime the mixture in a closed crucible. On repeating the process eight times, the gold is *killed*."

As the Hindu Iatrochemists were very particular about the *killing* of the metals being ensured, they had often to hit upon proper tests for securing this purpose Thus Rasaratnakara says :—"In order to examine whether the mercury has been completely reduced to ashes, it has to be heated over a gentle fire for three hours. If the weight remains constant, know then that it has been completely *killed*." In other words, it means that if there be any free mercury present, it would volatilise off and thus there would be a loss in weight.

According to Hindu alchemists, there are four kinds of the ash (*bhasma*) of mercury ; namely black (*kajjali*), red (*vermilion*), white and yellow. The white variety is often spoken of as *rasakarpura* or camphor of mercury ; it is often found to be almost pure calomel and sometimes a mixture in indefinite proportions of calomel and corrosive sublimate.

The chlorides of mercury are found to be medicinally used from the 12th century downwards, and various recipes are given for their preparation. The earliest account seems to occur in Rasarnava (Ch. XI, 24), where we find a mixture, among other drugs, of green vitriol, alum and salt, described as capable of *killing* mercury in an instant (p. 139) A more detailed description is found in Rasendrachintamani, a work which may safely be placed in the 13th–14th century. There the author Dhundhukanatha says: "I am now going to explain the process of preparing *rasakarpura*, which is a remedy for all diseases. take a strong earthen pot and fill one-fourth of it with common salt and place over it a mixture of brick-dust, alum and rock-salt. Rub mercury with the juice of Indian aloe and an equal weight of the above mixture into a paste, deposit it in the earthen pot and cover it with the same ingredients The pot is to be firmly closed with a well-fitting lid. Now apply heat for three days together."

Another work of the Iatrochemical Period, Rasendrasara-samgraha, describes the following process for obtaining the *svetabhasma* or white ash. "Rub mercury repeatedly with *pamsu* salt (i.e., *audbhida* salt) and the juice of *Euphorbia nerii-folia*: place the mixture inside an iron bottle, the mouth of which is closed with a piece of chalk. The bottle is embedded in a mass of salt, and then fire is urged for an entire day. The white deposit in the neck of the bottle is to be collected."

The Bhavaprakasa, written about 1500 A.D, prescribes calomel in the treatment of *phirangaroga* (lit. the disease of the Portugese; i.e., syphilis) and gives the following recipe: "Take of purified mercury, *gairika* (red ochre), brick-dust, chalk, alum, rock-salt, earth from ant-hill, *kshari lavana* (impure sulphate of of soda), and *bhandaranjika* or red earth, used in colouring pots, in equal parts; rub together and strain through cloth. Place the mixture in an earthen pot, cover it with another pot, face to face, and lute the two together with layers of clay and cloth. The pots so luted are then placed on fire and heated for four days, after which they are opened, and the white camphor-like deposit in the upper part is collected for use."

The chemical reactions, involved in the above methods for the preparation of calomel, may be explained as follows: Alum, magnesium sulphate or ferrous sulphate, when heated, yield some sulphuric acid. This reacts with common salt to liberate hydrochloric acid. The latter undergoes aerial oxidation in contact with ferric oxide from the brick dust, *gairika*, clay, etc., acting as a catalyst, and sets free chlorine, which attacks the mercury, giving rise to calomel. Alumina from alum or from clay may also catalyse the reaction to a certain extent like the ferric oxide.

CHEMISTRY IN PRACTICAL ARTS (II)

CHAPTER I

METALLURGY AND WORKING OF METALS

Copper, Bronze and Brass

We have already referred to an extensive use of copper, bronze and brass in ancient India during the Ayurvedic Period for making household utensils, weapons, and images of idols for worship. We shall deal here with their uses for the construction of guns and cannons by casting during the Mogul rule. Babar, the first Mogul Emperor, who first introduced guns in India, has given an account of the casting of a copper gun in his well-known memoirs. Babar writes: "Around the mould they had erected eight furnaces for melting the metal (copper). From the foot of each started a channel which ended in the mould. The fused metal rushed into the mould through these channels like boiling water, till the mould was filled up. * * * * A day or two afterwards when the mould had cooled down, it was opened. * * * * The bore of the piece had no fault and a chamber could easily be made in it. The body of the cannon was then uncovered, and a certain number of artificers were set to finish it. * * * * * * * * * * * ". Brass and bronze were subsequently used in quantities for this purpose It is stated that early in Aurangjeb's reign there were in the field with the Emperor some seventy pieces of heavy artillery, made mostly of brass. Some of these were so heavy and large that they had to be drawn and moved about with the help of 20 yoke of oxen.

As one of the notable brass guns of the Mogul time, mention may be made here of the "great gun of Agra", which had an enormous body of 14 ft. in length, and 22½ inch in bore, into which a man could easily enter in a crouching position Its weight was 1049 cwts., or 1469 maunds. It was lying near

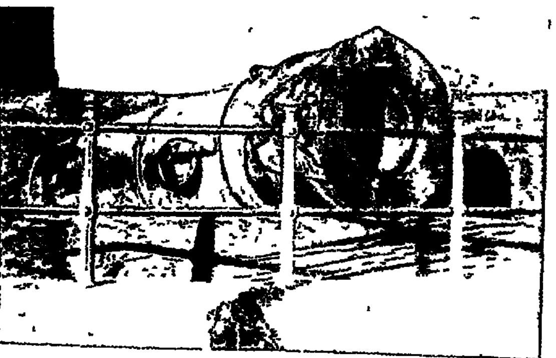


Fig. 31. *Malik-i-maidan*, bronze cannon at Bijapur
(Neogi, *Copper in Ancient India*).

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the bank of the river Jumna outside the fort at Agra Many of the Mogul guns and cannons were later on captured by the English. It is stated that a fine 72-pounder of brass, as well as 76 brass and 86 iron guns of different kinds, were seized at Agra by Lord Lake. Sixty-eight guns and mortars of brass, cast in India, were also captured by him at Delhi

But the most important gun of the Mogul time is the famous *Malik-i-maidan* (lit. monarch of the plain), made of bronze (Fig. 31). According to Fergusson and others it formed the largest piece of ordnance in the world at their time. The material of the gun on analysis revealed the following composition: Copper, 80.43 ; tin, 19.57 per cent. The dimensions of the gun are given by. Length, 14'-3"; diameter at mouth, 4'-10"; diameter at nozzle, 4'-5"; diameter at bore, 2'-4½". This huge piece of armament is now lying at Bijapur. The surface of the gun was chased after casting, and its muzzle worked into the shape of the head of a dragon, having open jaws with small elephants between It is said to be cast at Ahmednagar in 1548 during the reign of Sultan Burham Nizam Shah. The manipulation and skill, involved in casting such a gigantic piece of bronze armament, reflects no small credit to the workers of those days.

Many brass guns of smaller size, belonging to the Mogul period, are still to be found in different parts of India. Some of these, cast in the 16th century and known as Isa Khan's guns, have been discovered in Bengal. An analysis of a piece of metal from one of these shows the following composition : Copper, 87.72 ; zinc (with small quantities of iron), 10 32 ; tin, 1.83 per cent.

(The above account is taken from Neogi's *Copper in Ancient India*; p 38-39.)

Indications exist of mining and smelting of copper ores in the Singhbhum district of Bihar to have been carried on from a very early period. The evidence available points to the Seraks or lay Jains as being the persons who, perhaps 2000 years

ago, initiated the mining. (*Cf. Proc. Asiatic Soc. Bengal*, June 1869, p. 170).

Mining of copper ores and the extraction of the metal had been carried out on a large scale in the various states of Rajputana (Rajasthan) from a very early time till towards the end of the 19th century. The process in vogue during the later ages has been described in Ball's *Economic Geology of India*, as given below.

"The pounding or crushing was effected on a stone anvil with a hammer weighing eight or ten seers; when completely reduced to powder, the ore was made up into balls with cow-dung and roasted. The blast furnaces (Fig. 32) were prepared in the following manner. A quantity of common sand was spread on the door of a circular hut, in the centre of which a depression, 12 to 15 inches in diameter and 2 or 3 inches deep, was made; in this a layer of fine sand and another of ashes were laid to prevent the metal from adhering to the bottom of the receiver; two clay nozzles or tuyers were then placed on opposite sides of this hollow and a third between them, leaving the fourth side vacant for the slag to escape The nozzles were then connected by moist clay; and a circular rim of mud, a few inches in height, was raised, on which three annular vessels of fire-clay were placed to form the body of the furnace Each of these was 15 inches in external diameter, 10 inches high, and 3 inches thick. They were used repeatedly, but the lower part of the furnace had to be reconstructed for every charge. The bellows were simply goat-skins connected with the nozzles, and were worked by the families of the smelters. After a preliminary firing to dry the mud, the furnace was charged with charcoal, roasted ore and iron slag, the latter being employed as a flux. In a day of nine or ten hours' duration, 3 maunds of charcoal, 2½ of the roasted ore and 2 of the iron slag were consumed. The slag was drawn off, and the smelted copper, which had accumulated at the bottom of the furnace, was removed on the following day It was then remelted and refined in an open furnace under a strong blast from bellows,



Fig. 32. Copper reducing furnance at Khetri (Ball, *Economic Geology of India*).

and cast into small bars or ingots, which were subsequently removed to the Mint and cut up and fashioned into coins."

"The ore was said to yield only from 2½ to 7½ per cent. of metal. The quality of the metal is said to have been inferior to that of Basawar, this being attributed to the use of the iron slag as a flux ."

Iron and Steel

An account of the ancient historical specimens of iron in ancient India of the Ayurvedic period has been given before. We propose now to dwell on the specimens and products of the later ages.

Of these, the iron pillar at Dhar, the ancient capital of Malava, deserves our first and foremost attention. A full account of this pillar has been given by H. Cousens in the *Annual Report of the Archæological Survey of India*, 1902-03 (pp. 205-212). The Dhar Pillar (Fig. 33) is much larger than the famous Delhi Pillar, of which we have already discussed before. This pillar had a length 43'-8" as against 23'-8" of the Delhi Pillar. It is now lying broken in 3 pieces at different places. The first and the largest piece, 24'-3" in length and square in cross section, lies half-buried near the northern gate of the 'Lat Masjid' which was built near the pillar itself by Sultan Dilwar Khan in 1405 A D. The second piece, 11'-7" in length, now lies in the courtyard of the Ananda High School; its shape is not uniform, 8'-6" being square and 3'-1" octagonal. The third piece lies embedded in the masonry foundations of the public garden named Lalbag. It has a length of 7'-6" and is rectangular in cross section. The average width is 10 25 inches Several small holes surround the pillar, but they are not uniformly distributed The weight of the pillar is estimated to be seven tons, one ton greater than that of the Delhi Pillar. It is believed to have been constructed in the 12th century A.D. as a victory pillar. Like the Delhi

Pillar, this is also evidently made of wrought iron and in a similar manner. Cousens is of opinion that the holes or pits in the body of the pillar were made as the result of inserting some instruments like crowbars, while the pillar was being forged and welded.

There is another iron pillar, 12'-9" high, situated in the courtyard of the temple of Achaleswar on mount Abu in Rajputana. The pillar (Fig. 34) has a Saiva trisul or trident at its top and is evidently made of wrought iron in a manner similar to that of the Delhi and Dhar Pillars. It is stated that the pillar was built in the 14th century as a monument of victory.

In the temple of the sun-god at Konarak in Orissa, which is more or less in ruins, there are quite a large number of iron beams of great dimensions (Fig. 35) Some twenty-nine of these have been counted, the largest one having a dimension of 35 feet in length and 7 to 7½ inches in width with a square cross section. The beam has an approximate weight of 6000 lbs There is another beam measuring 23½ feet in length and 11 by 10½ inches in section, which was possibly a part of a much larger one It is stated that the temple at Konarak was built partly in the latter half of the 9th century A.D. (the main temple) and partly in the first half of the 13th century A.D (the *natmandir* and the minor temples).

In the temple of Juggernath at Puri in Orissa, which was built in the 12th century A.D., iron beams of quite large dimensions have been extensively used both in the main and the garden temples. In the latter as many as 239 iron beams have been counted. These range up to 17 feet in length and to 6 by 4 or 5 by 6 inches in cross section.

The iron used in making the beams for these Orissan temples is pure wrought iron. An analysis of a specimen from Konarak beams by P. Neogi gives the following results :

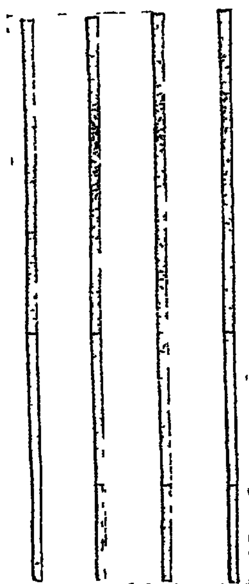


Fig. 33. Iron pillar at Dhar (Neogi, *Iron in Ancient India*).

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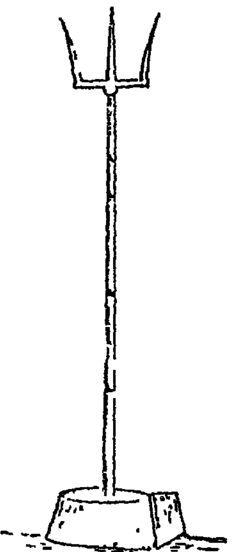


Fig. 34. Iron pillar at mount Abu
(Neogi, *Iron in Ancient India*)

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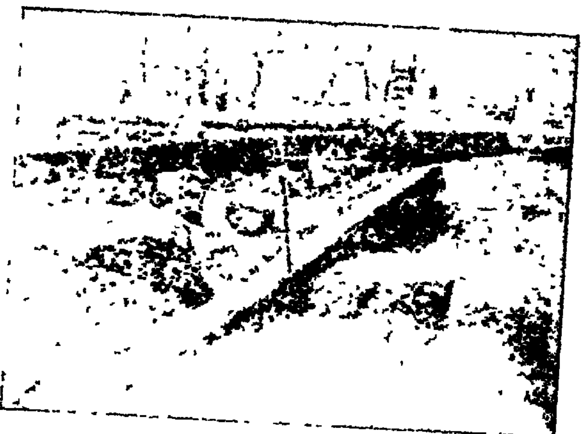


Fig. 35. Iron beams at Konarak
(Neogi, *Iron in Ancient India*)

Specific gravity :—		7.8
Iron	....	99.64 per cent
Carbon	.	traces
Sulphur	. ...	traces
Phosphorus	..	0.15 ,,
Manganese	... ..	nil

The composition is, therefore, very similar to that of the iron of the Delhi Pillar. But while the iron pillar at Delhi, as reported before (*vide*, p. 100), shows immunity to rusting even after centuries, the iron beams of the Konarak temple are more or less severely corroded. This seems to suggest that the moist and salt-laden air of the Orissan sea coast possibly provides a more favourable condition for corrosive action. This has been corroborated by the recent work of J. C. Hudson† of British Iron and Steel Research Association, who investigated the causes responsible for the remarkable resistance to corrosion shown by the Delhi Pillar, which has long been a subject of great scientific interest. Hudson has shown that the relative humidity of the air at Delhi seldom exceeds 70 per cent, which, according to the classical researches of W. H J. Vernon, serves as the critical limit for the atmospheric corrosion of iron and steel to set in. This should, therefore, lay to rest all speculations, and eliminate all hypothesis, regarding the alleged intrinsic superiority of the iron of Delhi Pillar, so far as its corrosion resistance is concerned.

P. K. Gode, in his article on the "Use of guns and gunpowder in India from A.D. 1400 onwards", adduces evidences in support of the view that guns were in use in India since 1400 A.D Mahun, a Chinese traveller, visiting Bengal in 1406 A.D., mentions that guns were to be seen in Bengal at that time. In the *Ancient Monuments of Kashmir* by R. Kak it is stated that fire-arms were first introduced into Kashmir in 1466. The employment of a force of musketeers and gunners at the siege of the fort of Champanar by Mahmud Bagda in

† *Nature* 172, 1953, p 499

1482 is recorded in the *Hindoo Annals of Gujerat* by A D. Forbes.

In memoirs of Babar we find that he used cannons and gunpowder near Kanauj in 1528

Description of iron guns and cannons are found in the Sanskrit work, entitled Sukraniti, or the 'Elements of Polity', by Sukracharya, which is possibly a compilation of the 16th century A D., though some authorities are inclined to place it at a much earlier date. Sukraniti describes two varieties of fire arms: *kshudra nalika*, small guns or match-locks, and *brihat nalika*, large guns or cannons. *Kshudra nalika* is 2½ cubits long, having a longitudinal bore of the thickness of the middle finger and provided with two raised points for the purpose of taking aims. These small guns were furnished with wooden handles *Brihat nalikas* or big guns had no wooden handles. They were moved about in carriages, and their range depended on the thickness of the metal plate and bore, as well as on their length.

We would now proceed to describe some specimens of very big iron guns of the Mogul days, found scattered in different parts of India. Most of these weigh about 30–47 tons. The maximum length found is about 31 feet, and the longest bore reaches about 1 ft. 7 in diameter. These guns were generally constructed of iron bars of square section laid longitudinally along the bore, over which iron rings were slipped, one at a time, while red hot. On cooling, they shrank and fastened the iron bars strongly together. Near the breech the guns were often strengthened by a second layer of rings

Many big iron guns have been found in different parts of Bengal, notably at Dacca, Murshidabad, Bishnupur and other places. A gigantic gun of hammered wrought iron was found at Dacca, which contained 234,413 cubic inches of the metal and weighed approximately 30 tons. The weight of an iron ball from this gun was found to be about 465 pounds. But the gun has disappeared now, having fallen into the river long ago, together with the bank on which it was

placed. It is stated that this gun was mentioned under the name of *Kaley Khan* by the Venetian traveller Manucci in the list of big cannons possessed by the Moguls in the 17th century.

There is a big iron gun at Murshidabad, named *Jahan-kosha* (conqueror of the world). It has a length of 17 ft 6 in. and a circumference of 5 ft. 3 in. (Fig. 36). From the inscription on the brass plate on its body, it is ascertained that the gun was constructed in 1637 during the reign of Emperor Shajahan.

In Bijapur there are some very big guns of the Mogul time. The famous *Landa Kesab* gun (Fig. 37) lies still on the south wall of the city. It is 21 ft. 7 in. long with a diameter of 4 ft. 4 in. at the breech. Its calibre is 1 ft. 7 in. and the bore length 18 ft. 7 in. The weight of the gun is estimated to be 47 tons.

There is another long gun, called the *Farflier* at Bija-pur, raised on the huge tower known as the Haider Burj. It is 30 ft. 8 in. long and has a bore of 1 ft. in diameter.

Finally, mention may be made here of the long gun at Gulbarga in Hyderabad (Fig. 38). It has got a double row of iron rings, ten on each side, by means of which the gun was possibly conveyed from one place to another.

Innumerable small muskets or iron match-locks (*bundooks*) of the Mogul days can now be found in the museums in different parts of India and in the treasure houses of Indian princes and landlords. It is stated in the *Ayeen Akbari* (an important administrative record of the reign of Emperor Akbar) that excepting Rum (ancient Turkey) no kingdom could compare with the Indian Empire under the Moguls in the number and variety of its ordnance. It gives a description of the manufacture of *bundooks* from wrought iron.

"*Bundooks* are now made in such a manner that when filled with powder up to muzzle, there is no fear of their bursting. Formerly, they never were of more than four folds of iron, and sometimes only of one, joined together by the two extremities

of the breadth, and they were very dangerous. His majesty (Emperor Akbar), after having the iron flattened, has it rolled up like a scroll of paper, but slantingly, and every fold is passed through the fire. There is also the following method : solid pieces of iron are properly tempered and then bored with an iron borer ; and three or four of these are joined together to form a bundook. In preparing the iron for bundooks half is lost in the fire." (*Ayeen Akbari*, Gladwin's Translation, Vol. I. p. 111.)

Reference has already been made in a previous section on 'Chemistry in Practical Arts' to the fact that steel had been prepared in Hyderabad, Mysore and Salem and other parts of Madras Presidency in India from a very early time, and it constituted the metal from which the famous Damascus blades were made. This steel was exported to Persia and the European countries under the name of *wootz* (*cf.* p. 102).

In Yuktikalpataru, a manuscript of the eleventh century, we find a list of places where swords were manufactured from Indian steel. Benaras, Magadha, Ceylon, Nepal, Anga, Mysore, Surat and Kalinga (Orissa) are the names of places mentioned therein. It also describes the qualities of the swords manufactured in those localities. A similar reference is also found in the Sarangadhara Paddhati, a work believed to be composed in the 14th century by the alchemist Sarangadhara. It mentions the following places noted for the manufacture of swords : viz., Khatikhattara, Rishi, Banga (Bengal), Shurporaka, Videha (Mithila or Trihut), Anga (Bhagalpur), Madhyama-gram, Bedidesha, Sahagram and Kalinjar. Dimensions and qualities of the swords, as well as the varieties of iron and their different colours, have been discussed in these two treatises.

Tinning and Alloying

The use of tin for coating household metallic utensils as a protection against acid food and metallic (copper) poisoning, may be said to have gained currency in India from the middle ages, possibly after the advent of the Muslims. The term *kalai*,



Fig. 36. Iron gun at Murshidabad (Neogi, *Iron in Ancient India*).



Fig 37 *Landa Kesab* gun at Bijapur (Neogi, *Iron in Ancient India*).

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Fig. 38. Iron gun at Gulbarga, Hyderabad (Neogi, *Iron in Ancient India*).

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current in many parts of India, means tin-coating The process is usually carried out by a class of people known as *kalaiwalas*, some of whom have regular shops, while others move from house to house Reference may here be made to an article by P. K. Gode of the Bhandarkar Oriental Research Institute of Poona, on the "History of tin-coating of metallic utensils in India between A.D. 1300 and 1900".

A copper container with coating of tin on both the surfaces —exterior and interior—has been found at Kolhapur (Brahmapuri excavation). The date, ascribed to it, is A D 1347–1500.

Abul Fazl in *Ayeen Akbari* has written of tinning copper vessels for his Majesty's (Emperor Akbar) use.

It may be noted here that the term *kalai* is adopted clearly from Arabic *calai*.

An alloy of considerable interest, produced in India since the Mogul period, has been named *bidery*, from Bider, a town 60 miles north-west of Hyderabad. It has a blackish colour and is composed of copper, lead and tin (8 : 2 : 1) These are melted together, mixed with spelter or zinc (16 parts for every 3 parts of the alloy) and the mixture melted again. It is then dipped into a solution of sal-ammoniac, saltpetre, common salt and blue vitriol, when the surface of the alloy turns black. According to another process zinc, copper and lead (30 : 1 : 1 approx.) are melted together, and a mixture of resin and bees-wax added to the mass in the crucible to prevent calcination. It was then poured into a mould made of baked clay. The article was finally turned in a lathe. Artists then inlay flowers and other ornaments of silver or gold. The article is first rubbed over with sulphate of copper and water to give the surface a blackish colour, which makes it easier for the artist to distinguish the figure drawn by him The cavities are then filled up with small plates of silver which adhere firmly to the *bidery*. It is then polished and stained Vases, basins, cups, etc., are made of it Some *bidery* is also made in the N. W. India and some in Bengal

Enamelling

The art of enamelling or fixing colours by melting in fire has been known in every part of India since the middle ages. It is chiefly employed in ornaments and jewellery of gold and silver.

In general 10 parts of lead and 3 parts of tin are oxidized by continued heat and exposure to air. To the mixed oxide are added 10 parts of powdered quartz and 10 parts of common salt. The mixture is melted in crucibles. A white enamel is thereby obtained, which forms the basis of coloured enamels A soda-lead glass with tin oxide in suspension is thereby produced. The metallic oxides are added to this for colouring. The oxides of lead or of antimony produce a yellow enamel. Red enamels are obtained by a mixture of the oxides of gold and iron. The oxides of copper, cobalt and iron give green, blue and violet respectively, and a variety of intermediate colours by mixtures.

Recovery of Gold from the Wastage of Gold Working

From the time of Emperor Akbar, and possibly even earlier, some processes have been in vogue in India for the recovery of gold from the waste that results in the course of preparing jewelleries These are generally carried out by more or less illiterate people of the artisan class.

In joining together the parts of jewellery, a certain amount of gold is lost with the pieces of solder which fly off before the blow-pipe ; a little loss also occurs by volatilization, as the solders usually contain zinc. The operations of filing and cutting lead to a further loss by mechanical causes. But an appreciable loss of gold occurs during the chemical operations of the goldsmith, which consist in cleansing, colouring and polishing of the articles. The gold employed for making jewelleries is never pure, as pure gold is too soft for working An alloy of gold and copper is always used for the purpose.

During heating, the surface of the article is blackened due to oxidation and formation of cupric oxide. This is intensified by hammering in the intervals between repeated heating Mention may be made in this connection of a particular artifice, which is sometimes employed by the goldsmiths to cleanse the surface of a gold-copper alloy that has been blackened by fire. It is found that if a blackened piece of gold copper alloy be heated in a charcoal fire to redness, and then water be sprinkled on the fire, the alloy at once acquires the bright colour of gold. The explanation of the phenomenon seems to be that, when placed in a charcoal fire, the cupric oxide is reduced to metallic copper But if it is taken out when hot, it comes into contact with the air again and is oxidized What the goldsmith does, is to suddenly cool down the metal when in the reduced state, and not to allow it to come into contact with the open air unless it is quite cold. This prevents reoxidization and hence blackening

The gold ornaments are usually coloured bright red or orange, and sometimes reddish violet. The process of colouring, as practised by the goldsmiths or by the *rungwalas*—a class of people whose sole business is to colour ornaments or other articles of gold, involves rather cumbrous and complicated chemical operations. The process may be briefly described as follows· The articles are first cleansed of all external dirt, as well as of the blackness, due to the formation of cupric oxide on the surface when heated in a charcoal fire. They are then placed in a bath of boiling concentrated decoction of unripe fruits of tamarind (*Tamarindus indica*). This liquid contains considerable amount of tartaric and other acids in the free state. These acids dissolve away the copper oxide from the articles, leaving a yellow surface of pure gold. This is indicated by the fact that the solution of the tamarind pulp becomes distinctly blue in virtue of the formation of copper salts This treatment also removes the oxide of zinc from the soldered surface. The articles, thus cleansed, are then covered with a thin layer of a paste, made of equal parts of common salt and potash alum,

and afterwards placed on the fire. After the paste is dried up, it is washed off with water. The colour of the gold is thereby somewhat improved, as this treatment removes any particles of oxides of copper still remaining on the surface.

As a result of the above treatments the articles acquire almost the beautiful yellow colour of pure gold: but the soldered surface appears at the same time as white as pure silver. This defect is then remedied by the next process to be described now. A mixture consisting of four parts of nitre, one part of common salt and one part of alum is added to water in an earthen pot. The amount of water used is such that about half the amount of salt mixture remains undissolved. The solution is then heated till it boils, evolving large quantities of gases and fumes, which obviously contain chlorine as a constituent. In this boiling solution the cleansed articles are kept immersed for a time, till a layer of shining gold is formed on the surface of the white solder, and the entire surface presents the appearance of being formed out of a homogeneous material. The articles are then taken out and washed. The reactions that occur during the above process may be explained as follows. When the salt mixture is boiled with water, chlorine and nitrosyl chloride are evolved. These act upon the gold forming a solution of gold chloride. The latter coming in contact with the white soldered surface deposits gold upon the latter, masking its white colour. It is clear that a considerable amount of gold is lost by solution in this treatment. The residual fluid, containing the dissolved gold and known as *jamak*, is, therefore, considered valuable and sold to a class of people called *jamakwalas*.

The articles, after being removed from the boiling *jamak* solution, are thoroughly washed and rubbed with a brush. They are then ready for treatment in another bath. This consists of a solution of tamarind pulp, nitre and common salt in water, which is placed in an earthen pot on fire and heated to ebullition. A little sulphur is then added after which the articles are placed in the liquid. The sulphur is added in a

finely divided state obtained by rubbing a stick of sulphur with a little water on a piece of slate. Care is always taken to add an insufficient amount of sulphur at first, for it is found that the shade of colour that is produced on the gold depends solely on the quantity of this ingredient, which accordingly requires exceedingly careful regulation. The colour of the articles is now examined from time to time, adding more sulphur gradually for increasing the depth of colour. When the requisite shade of colour is reached, further addition of sulphur is stopped. The boiling is continued for some time more, after which the articles are taken off the solution and given a final wash and polish. Addition of too much sulphur renders the colour deep violet and finally black The chemical reactions, that occur during this stage of colouring, are rather obscure. P C. Ray, in his book, has suggested a tentative explanation to account for the formation of violet colour on the surface of the metal by the treatment described. According to this view the solution of nitre and common salt, when boiled along with the acids from the tamarind pulp, is likely to liberate chlorine. This attacks the gold giving rise to auric chloride in solution: the addition of sulphur serves to remove the excess of chlorine, due to the formation of sulphur chloride. The auric chloride slowly breaks up into aurous chloride by heat, and the liberated chlorine is taken up by sulphur. The aurous chloride is then changed into aurous oxide, which is deposited in the form of a thin violet layer on the surface of the articles The explanation appears to be a very probable one, as aurous oxide possesses a dark violet colour and is produced from auric chloride, when a solution of the latter is boiled with salts of organic acids. A considerable amount of gold is also lost in this process.

We shall now proceed to describe the methods employed for the recovery of gold that is lost during the above processes of working of gold for the making of jewelleries and ornaments by the goldsmiths In Bengal, for instance, there are two small classes of people who have been earning their livelihood for

a long time by recovering gold from the refuse and waste liquors of goldsmiths' shops. These are known by the names of *neharwala* and *jainakwala*.

It is a common practice in every goldsmith's shop in India that the daily sweepings and other refuse of the rooms are never thrown away, but stored up carefully in one place The heap of rubbish and dust, thus accumulated from day to day, are finally sold to *neharwalas* (from *nehar*, which means sweepings). The heap of rejected earthen crucibles, employed for melting gold, is also sold to them. Sometimes the soot hanging from the ceiling and walls is also purchased. Even the dust collected by shaking the workmen's mats, as well as the sweepings obtained from the space underneath, are sold to the *neharwalas*

The heap of dust and the refuse matters are ground fine by the *neharwalas*. The crushed materials are soaked in water in a big earthen pot for several days. They are then agitated with a large amount of water, when the lighter earthy materials float and remain in suspension, whereas the heavy metallic particles settle at the bottom. The supernatant water with its earthy suspension is then allowed to run out. The process is repeated till the solid matter is reduced to a small bulk. The residue is then dried up either in the sun or on fire The dried remnants of several washings are mixed together, and the mixture is washed once again. The metals present in the washed mixture generally include iron, which is removed by picking out with fine pincers. In later days, the use of magnet for the purpose has come into vogue. The mixture is then melted in a large crucible. The earthy matter sticks to the sides of the crucible, while the metallic portion melts and falls to the bottom. A button of gold, silver, copper and zinc is thus obtained. Gold is then extracted in a pure state from this alloy. For this purpose, the alloy is beaten into thin leaves Each leaf is then covered with a thin layer of a paste of brick dust and common salt. The leaves are finally arranged one above another and exposed to the heat of a fire. After a certain number of days, depending on the nature of the alloy and the

temperature of the fire, the gold is found to be very nearly pure. This method has in the later ages been entirely superseded by the far easier and more economical process of treating the alloy with strong nitric acid. For this operation, however, the alloy must be reduced to a fine state of division. This is effected rather ingeniously by melting the alloy and then suddenly dropping the molten metal into water. By this means the metal is at once reduced to a fine powder

It has already been stated that a considerable amount of gold is lost during the processes of cleaning and colouring the ornaments. The waste liquor after these treatments, known as *jamak*, is sold to the *jamakwalas*. Gold is recovered from the *jamak* by the *jamakwalas* by a process, briefly described below. The waste liquor or *jamak* is boiled in an earthen vessel to reduce the volume. When practically the whole amount of water has been evaporated off, the viscous mass is removed to an open earthen vessel. This is then mixed thoroughly with a small quantity of borax and a large quantity of a substance, known as *poonoor* (a mixture of partially oxidized lead, copper and zinc with traces of silver and iron). The mixture is made into balls of about 2-3 inches in diameter with the addition of sufficient cow-dung. The balls are then dried perfectly in the sun, or over fire. *Poonoor* is a by-product, obtained during the purification of silver when alloyed with copper and other metals. For this purpose, the alloy of silver is mixed up with a large quantity of lead, and the mixture is melted on a small hearth ; air is then blown over the molten mass, when the pure silver separates and collects at the bottom. The partially oxidized lead, together with impurities originally present in the silver, constitutes what is known as *poonoor* This operation for the purification of silver resembles practically that of cupellation.

The balls containing the waste gold, as prepared above, are placed in a small hearth, the interior of which is covered with a layer of slaked lime about half an inch thick. The hearth is made by scooping out on the earth in an open place a hollow of

the shape of a hemisphere about a foot in diameter. A powerful charcoal fire is produced over the balls in the hearth, which is aided by blowing air with two or three large pairs of bellows A large metallic mass ultimately collects at the bottom of the hearth, consisting mainly of lead. As the blowing is continued, lead is oxidized to litharge and gradually blown off. As the whole of the lead has passed off in this way, a mixture of gold, silver and copper remains behind.

The *jamak* or the waste liquor was found on analysis by P. C. Ray to contain bases like silver, copper, zinc, gold, aluminium, potassium and sodium; while amongst the acids present, nitric, hydrochloric and sulphuric were recognized in large quantities. Traces of free chlorine could also be found in some of the solution, while perceptible amounts of iron were found in almost all A microscopic examination of the material revealed octahedral crystals of alum, rhombic prisms of nitre, and the cubic crystals of common salt Besides these, there were observed small numbers of long, transparent needles of the crystals of $NaAuCl_4.2H_2O$. Fine particles of free gold were also detected.

CHAPTER II

GUNPOWDER, SALTPETRE, THE MINERAL ACIDS, ALUM, ETC.

That the knowledge of the art of manufacturing gunpowder was known to Indians in the 16th century A.D., seems to be supported by the several recipes given in the Sukraniti or the 'Elements of Polity' of Śukracharya. The translation of relevant verses is given below:

"Take five palas of saltpetre, one pala of sulphur and one pala of charcoal, prepared from the wood of *Calotropis gigantea* and *Euphorbia nerrifolia* by destructive distillation; powder them and mix them intimately, and macerate them in the juice of the above-named plants and of garlic; afterwards dry the mixture in the sun, and pulverise it to the fineness of sugar. Gunpowder (lit. fire-powder) is thus obtained." 201-202

"If the fire-powder is to be used for a gun, six or four palas of saltpetre are to be taken, the proportion of charcoal and sulphur remaining the same as before." 203

"For a gun with a light barrel, balls of iron or of other metals are to be used." 204

"The guns made of iron or other metals are to be constantly kept clean and bright by the skilful artillery men". 205

"By varying the proportion of the ingredients, viz, charcoal, sulphur, saltpetre, realgar, orpiment, calx of lead, asafoetida, iron powder, camphor, lac, indigo and the resin of *Shorea robusta*, different kinds of fires are devised by the pyrotechnists, giving forth flashes of starlight." 206-208

From the circumstantial details given in the verses quoted above in translation, especially from the method of preparing the charcoal, one is naturally led to suspect that the lines relating to gunpowder are later interpolations. This is



In a publication on *The History of Fireworks in India* (between 1400-1900 A.D.) Gode has quoted formulae for the manufacture of specific fireworks from a Sanskrit work called the Kautukachintamani by Gajapati Prataparudradeva of Orissa, a royal author, who flourished in 1497-1539 A.D. From the manuscript of this work, as was available in the Government Manuscripts Library at the Bhandarkar Oriental Research Institute at Poona, Gode has noted down the following materials used in the manufacture of fireworks, as found in the Sanskrit verses

Sulphur (*gandhaka*), saltpetre (*yavakshara*), charcoal (*angara*), steel and iron powder (*tikshna loha churna* and *loha churna*), copper carbonate (*jangala*), yellow orpiment (*talakam* or *harital*), ochre (*gairika*), wood of 'khadire' tree (*khadiram daru*), hollow bamboo piece (*nalaka*), wick (*bartika*), five salts (*pancha kshara*), lodestone (*akhupashan*), pulp of castor seeds (*aranda majja*), mercury (*sutam*), rice paste (*annapista*), tin or lead (*naga*), charcoal from the 'arka' wood (*arkangara*), cow's urine (*gomutra*), cinnabar (vermilion).

It may be assumed as suggested by Gode (loc. cit) that some of the recipes for fireworks in India might have been brought from China and then modified by the substitution of Indian ingredients for the Chinese materials. For, fire-works, fire-arms, and military pyrotechnics were developed in China much earlier than in any other country. The Chinese had real fire-arms in the 13th century A.D., and they achieved considerable skill in manufacturing fireworks Preparation of explosive powder, containing sulphur, charcoal, saltpetre, paper, oil, etc., for military purpose, was known to them as early as 1000 A. D *

A description of fireworks and guns also occurs in another Sanskrit work, called Akasabhairava Kalpa, found in the form of

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* L Davis and J R Ware, *Early Chinese Military Pyrotechnics*. *Journal of Chemical Education*, 24, 1947 522

a manuscript in the Tanjore Manuscript Library. (*cf* Gode, loc. cit.)* This treatise, according to Gode, obviously belongs to a period later than 1400 A.D

Gode (loc. cit) has further referred to the description of a display of fireworks in a marriage procession in a Marathi poem Rukmini Svayamvara, composed in 1570 A D. by the saint Ekanatha. Varieties of rockets and other fireworks are described in the poem.

From the description given of fireworks in India by Verthema and Barbosa in their *Travels* (1502-1518 A D), Gode concludes that fireworks were manufactured in India on a large scale at a time near about 1500 A.D. for use during marriage ceremonies and other festive occasions

Among the varieties of fireworks, still in use in India mention may be made of the cracker in different forms, known as *gola*, *patka*, *vengagvedi*, *koroo*, *adirvedi*, etc. Chinese fire-mixture, used in India and burnt in earthenware pots, is known as *tubri*. Other fireworks used in India are *anar*, *phuljhuri*, *burusu*, *chandrajyoti* or *mehtab* Rockets are known as *hawai* or *abusavanam* and called *bana* in the Sanskrit works.

Saltpetre

Sauvarchala stands for saltpetre in Rasarnava and Sukraniti. It occurs extensively in Bengal and in upper India as an efflorescence on the soil.

Saltpetre has been in use in India from a very early time as the basis of rocket and other fireworks. In the Dasakumaracharita by Dandi (circa 6th century A.D.) mention is made of *yogavartika* (magic wick) and *yogachurna* (magic powder), of which saltpetre was probably the basis. The

* See Gode's paper on Akasabhairava Kalpa, *Karnatak Historical Review*, 1939

earliest account of the manufacture of saltpetre on a commercial scale in India, that has come to our notice, occurs in a work entitled, *The Travels of John Albert de Mandelso from Persia into the East Indies*, London, 1669. It describes the process as follows :

"Most of the saltpetre, which is sold in Guzuratta, comes from Ajmer, sixty leagues from Agra, and they get it out of land that hath lain long fallow. The blackest and fattest ground yields most of it, though other lands afford some, and it is made thus: they make certain trenches which they fill with their saltpetrous earth, and let into them small rivulets, as much as will serve for its soaking, which may be the more effectually done, they make use of their feet, treading it till it becomes a brooth (broth). When the water has drawn out all the saltpetre which was in the earth, they take the clearest part of it, and dispose it into another trench, where it grows thick, and then they boil it like salt, continually scumming it, and then they put into earthen pots, wherein the remainder of the dregs goes to the bottom; and when the water begins to thicken, they take it out of these pots, to set it adrying in the sun, where it grows hard, and is reduced into that form wherein it is brought into Europe." pp. 66-67.

Mineral Acids

The distillation of alum is referred to in Rasarnava, and of green vitriol in Rasaratnasamuchchaya. We have, however, no evidence that the acid thus derived was ever used as a solvent. At the same time, it might be pointed out that Rasarnava and similar other works lay stress upon *vida*, in which aqua regia may be said to be potentially present, and which is fitly described as capable of *killing* all the metals.

The preparation of mineral acids is incidentally described in several exclusively medical works, composed probably in the 16th and the 17th centuries; e.g. in Rasakaumudi by Madhava, Rasaratnapradipa and Bhaishajyaratnavali by

Govindadasa, etc . . . . . . In the last work under the heading of *mahadravakarasa*, directions are given for distilling a mixture of, among other things, alum, green vitriol, sal-ammoniac, saltpetre and borax in a glass retort In this way a dilute solution of nitro-muriatic acid is obtained, which is prescribed in the derangement of liver and spleen. There is a similar recipe in which, in addition to the above ingredients, rock-salt and sea-salt are used, thus yielding what is called *samkhadravaka* (lit. solvent for conch-shell).

The term *dravaka* (solvent) seems to have been expressly coined to do duty for the mineral acids. We have seen all along that in the older works *dravaka* was used invariably in the sense of solvent or flux, but never in the sense of a mineral acid, the knowledge of which seems to have spread both in the east and the west almost simultaneously. The regular application of the mineral acids to technical operations dates from the time of Emperor Akbar or perhaps a little earlier Thus in the *Ayeen Akbari* under the "Method of Refining Silver" mention is made of the use of *rasi* (aqua fortis). It is not easy to make out how much of the processes of the assay of gold and silver, as described in the *Ayeen*, is of earlier origin

Alum and Green Vitriol

Alum, with green vitriol, is distinctly referred to in the Susruta under the names of *saurashtraja* (lit. begot of Saurashtra—Surat) and *kasisa* respectively From the ancient times the earth of Surat has been known to yield this mineral (alum). The following synonyms of alum, *kamkshi*, *tuvari* and *saurashtraja*, are found in Amarkosha (600 A.D.) Rasaratnasamuchchaya also gives the same synonyms.

As we find from Ball's *Economic Geology of India*, the old indigenous process for the manufacture of alum survived even to the end of the 19th century A.D.. "Alum is principally used as a mordant in dyeing, but as a drug its employment is extensive

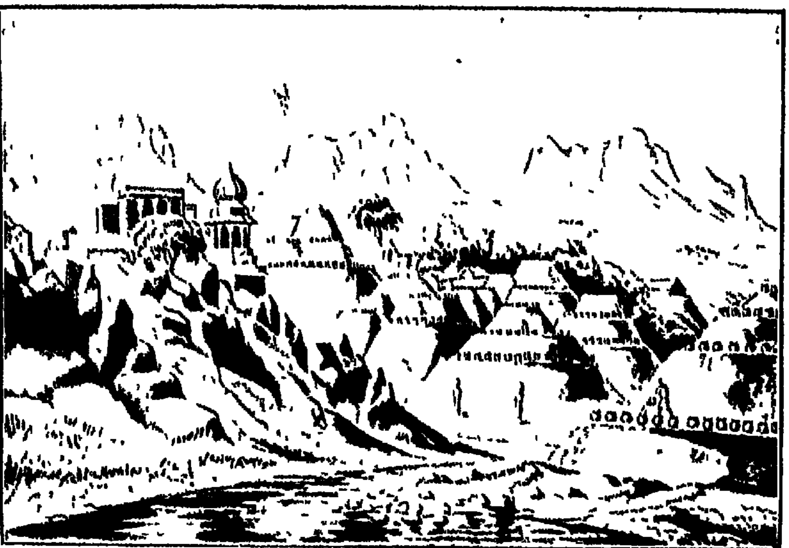


Fig. 39. Alum and sulphate of copper works at Khetri, Rajasthan
(Ball, *Economy Geology of India*).

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in India. In two localities in Rajputana alum shales occur in quantities, from which alum was prepared. A small quantity was manufactured from slates obtained in the district of Sahabad in Bihar. Copperas or iron sulphate also occurs in the same region."

In connection with the copper mines at Rajputana, Khetri and Singhana, considerable quantities of blue vitriol, copperas and alum were used to be manufactured till the end of the 19th century. It is stated that in 1864 A.D. there were twenty of these factories at Khetri and about double the number at Singhana. "The process of manufacture consisted in the lixiviation of the broken shales from the mine with water in a series of earthen *gharas* (vessels), arranged on ledges prepared for the purpose on the heaps of refuse. The shales were mixed with the crusts derived from the previous lixiviation (Fig. 39). Each charge of shale was subjected to the action of three changes of water; and the water itself was changed from one *ghara* to another, till it had taken up sulphates from seven different steepings. It was then of a thick dirty-bluish colour and taken to the boiling house, where it was boiled in earthen *gharas*; when sufficiently concentrated, it was left to cool; and thin sticks being introduced, the blue vitriol crystallized on them. The mother liquor was then poured off and again boiled, and on the addition of saltpetre, the alum crystallized at the bottom of the vessel. The residual sulphates still in solution were allowed to crystallize out by exposing the mixture to the sun."

The manufacture of alum in Cutch from a pyritous dark-grey or black shale in large quantities had also been in vogue for a long time. It is stated that before 1818 the exports of alum from this source amounted in some years to several thousand tons. These mainly went to Guzerat and Bombay to be employed in dyeing. The process has been described as follows:

"The shale is excavated from pits and is exposed for four months, a slow combustion taking place owing to the decompo-

sition of the pyrites. It is then spread in squares resembling salt pans and sprinkled with water. After about twelve days it consolidates into efflorescing mamillated crystalline plates or crusts, called *phitkari-ka-bij* or seed of alum. These crusts are boiled in large iron vessels (lined inside with lime), together with saltpetre (or other potash salt), in the proportion of 15 of alum seed to 6 of the latter; when it has settled, the liquor is placed in small earthen vessels somewhat the shape of flower-pots, and crystallization takes place in three days. The crystals are again boiled one or more times to concentrate the solution, which is finally ladled into large thin bladder-shaped earthen *mutkas* or *gharas* with small mouth; these are sunk into the ground to prevent their breaking, and in five days the alum is found crystallized in masses. The vessels are then broken, and the alum is stored.

"Alum is also manufactured from the water of a hot spring north of Minur in Cutch. The impure saltpetre, required for making alum, is obtained by lixiviation of village refuse."—Ball's *Economic Geology of India*, pp. 431-33.

Iron Sulphate

"The green vitriol or copperas of commerce, which is known to the natives as *kahi* and *hara kasis*, is produced principally from the so-called alum shales, from which alum is prepared. As is the case also with alum, copperas is found sometimes as a natural exudation upon alum shales and other rocks, which include iron pyrites.

"This native copperas goes by several different names in India, according to the nature of the other substances with which it is combined.

"In the year 1833, Mr. J. Stevenson published an analysis of native sulphate of iron obtained from Bihar, which was used at that time by the native dyers of Patna.

Analytical results :—

Iron sulphate	.........39.0 per cent.
Iron oxide	.........36.0 „
Magnesia	.... 23.0 „
Loss	.... 2.0 „ ."

—Ball, loc. cit., p. 419.

CHAPTER III

PAPER, INK, SOAP, COSMETICS, ETC.

The art of paper-making was possibly introduced into India from Nepal at or about 1000 A.D. It attained a high degree of technical excellence in Nepal in those early days. It was from China that paper came to Nepal. The industry flourished in China much earlier and entered Nepal between the 7th and 9th centuries A.D., when the Chinese influences impressed themselves deeply on Nepalese culture and civilization. Nepal paper once commanded a very extensive market, and was exported southwards to Hindusthan and northwards to Sokyagumba, Digarchi and other places in Bhote. It was used all over Kumayun and was sold at Patna, Saran, Jankipur, Darbhanga, Purnea, Gorakhpur, Balarampur and Tandah in Oudh.

The view that the art of paper-making was brought to India by the Moguls is no longer acceptable. No direct connection can be traced between the Nepal paper-making and the Mogul court. The process followed in Nepal differs considerably from those practised in Kashmir and the Punjab under the imperial patronage.

Mahaun, the Chinese interpreter, who visited Bengal in A.D. 1406, stated that the people of Bengal manufactured paper from the bark of a tree, and that the paper was smooth and glossy like a deer's skin.

During the Mogul and the Peshwa period the industry flourished throughout the whole country, mostly in the Punjab. It is said that Sialkot produced paper worth 9 lacs of rupees in Jehangir's time. Paper was produced at Multan, Rawlpindi, Jalalpur, Delhi, Lahore, etc. . . . The materials employed were old clothes, old tents, the bark of certain shrubs and trees, etc. . . . . These materials were beaten with a wooden hammer or *dhenki*, after having been well-washed and soaked in water for several

days. The pulp was mixed with a little water in a lime-lined (*chunamed*) reservoir, where the beating operation was also carried out. The workmen dip their moulds into the reservoir, and the mixture, when lifted out, instantly becomes paper. This is then removed, and each sheet is drawn through a second reservoir of water and then hung up to dry. A quality of gum arabic was dissolved in the water into which the beaten pulp was put; the water in the second reservoir, through which the sheets were drawn, also contained that gum in the form of a mucilage, as well as some alum dissolved in it. The moulds or forms of the workmen are generally made of bamboo. The gum (gum arabic) is obtained as an exudation from a tree, known commonly as the *babool* tree.*

Soap

Soap was possibly introduced into India by the Mohammedans, though the Hindus had made use before of alkaline lyes for a long time, obtained from the ashes of plants. They had also a substitute for soap in several berries. The crude soaps were made in the beginning from *sarjikakshara* (trona or natron), common salt, sesamum oil and goat's suet.

Ink

Ink was used to be prepared in early days in India, both in the solid and in the liquid form, from lampblack collected by burning linseed oil in an earthen lamp. This was mixed with the gum of *Vachelia farnesiana* and a little water, and then rubbed in an iron mortar with a wooden pestle for several hours. This paste was afterwards treated with an infusion of gall-nut in water, and the whole mass was ground again in the same iron mortar for a few hours. The pasty mass was finally

* References — P K. Gode—*Studies in the Regional History of Paper Industry, Migration of Paper from China to India*
K B Joshi—*Paper-Making*; All India Village Industries Association, Maganwadi, Wardha, 1944

dried in the sun to admit of its being made into lumps. The lumps again were further dried by sun's heat.

Rasaratnakara of Nityanathasiddha, an alchemical treatise of the thirteenth century, gives the following recipe of ink for writing on palm-leaves and birch-bark.

The following ingredients are necessary for making indelible black ink :

(1) The three myrobalans,

(2) *Eclipta alba*,

(3) yellow berberis,

(4) *Semicarpus anacardium*—marking nut,

(5) oleander, *Nerium odorum*,

(6) *bob*—a variety of gum,

(7) *kajjal* or lampblack,

(8) copper vessel.

The indelible character of the ink is obviously due to the use of marking nut, which, as is well known, is used by the washermen in India for marking clothes.*

Cosmetics and Perfumery

The use of cosmetics and perfumes, and the knowledge of their preparation were known in ancient and medieval India. P. K. Gode, in his article on *Indian Science of Cosmetics and Perfumery*, refers to two Sanskrit treatises on the subject, believed to be composed sometime between A.D. 1000-1200. These, as their contents indicate, were based on earlier texts, some of which are partly extant, and were composed between A.D. 500-1000. The two treatises recovered by him are: (1) 'Gandhasara' by Gangadhara and (2) 'Gandhavada' by an anonymous author, with a commentary in Marathi.

* *Cf* P. K. Gode's article on the *History of Ink Manufacture in Ancient India*, *Pracyavani*, Vol III, 4, 1946 p 10-11.

In one of the chapters in Gandhasara by Gangadhara, the author describes how to examine and use the several aromatic ingredients for the preparation of cosmetics and perfumes. His classification of the aromatic ingredients in different *vargas* or classes is quite scientific, and deserves particular mention here. The aromatic ingredients are classified as :

(1) Leaves —holy basil leaves, etc.

(2) Flowers —saffron, champaka, clove, etc.

(3) Fruits —pepper, nutmeg, cardamum, etc.

(4) Barks —bark of camphor tree, bark of clove tree, etc.

(5) Woods —sandal wood, fir wood, etc.

(6) Roots —nut-grass (*Cyperus rotandus*), *vala* (*Pavonia odorata*), etc.

(7) Exudations from plants—camphor, etc.

(8) Organic products—musk, lac, etc.

The treatise Gandhasara by Gangadhara contains three chapters. Chapter I explains the technical processes and terminology of the science of scents and perfumes. Chapter II gives recipes for the preparations of different perfumed products, such as perfumed waters, oils, sticks, powders, incense, etc. Chapter III gives a classified glossary of aromatic ingredients to be used for the preparation of cosmetics and perfumes Some of the technical processes, given in this treatise for the preparation of cosmetics and perfumes, have been quoted by Gode in his paper. These are six in number, viz :

(1) *Bhavana* —infusing or saturating powders with fluid.

(2) *Pacana* —ripening, or decoction of materials after they have passed through previous process of *bhavana*.

(3) *Bodha* —strengthening the scent of a perfume with the help of aromatic ingredients, serving as intensifying agents.

(4) *Vedha* —this seems to represent a further development of *bodha* or intensification process.

(5) *Dhupana* —fumigating with aromatic vapours of incense, etc.

(6) *Vasana* —preparing scents with perfumes of flowers

The processes described are quite systematic, and appear to be based more or less on a knowledge of physico-chemical principles.

CONCLUSION

DECLINE OF SCIENTIFIC SPIRIT IN INDIA

In ancient India the useful arts and sciences, as distinguished from mere handicrafts, were cultivated by the higher classes. In the White Yajurveda and in the Taittiriya Brahmana, we meet with the names of various professions which throw light on the state of society of that period; unfortunately a knowledge of these perished with the institution of the caste system in its most rigid form. Among the sixty four *kalas*, or arts and sciences, which are enumerated in the old work of Vatsayana, called Kamasutra (circa 5th century A.D.), occur the names of the following :

Subarnapariksha—the examination and valuation of gold and gems.

Dhatuvada—chemistry and metallurgy.

Manıragakarajnanam—knowledge of the colouring of gems and jewels, as also of mines and queries.

In the Sukranitisara or the 'Elements of Polity' by Sukracharya, we also read an account of the various *kalas*, e.g. :

1. The art of piercing and incinerating the stones and the metals is known as a *kala*.

2. A knowledge of the combinations of the metals and the herbs or plants is also regarded as a *kala*.

3. The art of alloying and separating the metals is also known as a *kala*.

4 The art of extracting alkali is likewise counted as a *kala*.

In the science of Ayurveda there are altogether ten *kalas*.

We also find that among the companions of the poet Vana (7th century A.D) were an assayer and a metallurgist. Such terms as *lohavid* and *dhatuvid*, which occur repeatedly

in Sanskrit literature, show that the metallurgists were held in high regard, and the specialized knowledge was in great demand.

The art of dyeing was carried almost to perfection the fast colours resembling the Tyrean purple.

In the Vedic age the *rishis* or priests did not form an exclusive caste of their own, but followed different professions according to their convenience or natural tastes. But all this was changed when the Brahmins reasserted their supremacy on the decline or the expulsion of Buddhism

The caste system was established *de novo* in a more rigid form. The drift of Manu and of the later Puranas is in the direction of glorifying the priestly class, which set up most arrogant and outrageous pretensions. According to the Susruta, the dissection of dead bodies is a *sine qua non* to the student of surgery, and this high authority lays particular stress on knowledge gained from experiments and observations. But Manu would have none of it. The very touch of a corpse. according to Manu, is enough to bring contamination to the sacred person of a Brahmin. Thus we find that shortly after the time of Vagbhata, the handling of a lancet was discouraged and anatomy and surgery fell into disuse and became to all intents and purposes lost sciences to the Hindus. It was considered equally undignified to sweat away at the forge like a Cyclops. Hence, the cultivation of the *kalas* by the more refined classes of the society, of which we get a vivid picture in the ancient Sanskrit literature. has survived only in traditions since a very long time past.

The arts thus being relegated to the low castes, and the professions made hereditary, a certain degree of fineness. delicacy and deftness in manipulation was no doubt secured. but this was accomplished at a terrible cost. The intellectual portion of the community being thus withdrawn from active participation in the arts, the *how and why* of phenomenon—the co-ordination of cause and effect—were lost sight of. The spirit of enquiry gradually died out among a nation. naturally

prone to speculation and metaphysical subtleties, and India for once bade adieu to experimental and inductive sciences. Her soil was rendered morally unfit for the birth of a Boyle, a Descartes, or a Newton, and her very name was all but expunged from the map of the scientific world for a time.

In this land of intellectual torpor and stagnation, the artisan classes, left very much to themselves and guided solely by their mother wit and sound common sense, which is their heritage in this world, kept up the old traditions. In their own way they have displayed marvellous skill in damescening, making ornamental designs on metels, carving on ivory, enamelling, weaving, dyeing, lace-making, goldsmith's and jeweller's works, etc But the zeal for the pursuit of truth disappeared, and the study of chemistry as a science suffered a serious set-back.

As a matter of fact, science in India proceeded in a wrong way with the pursuit of alchemy and occultism, and, in consequence, came to stagnation and decay in the late Middle Ages. For, the same mechanism, it may reasonably be assumed, possibly works in the evolution of human mind, revealed by its civilization and culture, as in the organic evolution, proceeding through the combination of *adaptation, natural selection* and *mutation*. The last named gives a new and fruitful turn to the course of evolution, when it runs into a blind alley, leading either to an extinction or arrest. In the case of mental evolution there is, however, one difference; while in organic evolution the organism itself has no control over the mechanism, acting merely as an instrument, in the case of mental evolution, on the other hand, the mind takes an active part in the process, either co-operating with, or acting in antagonism to, the evolutionary urge or force Hence, the phenomenon of mutation assumes a greater significance in this case. In the mental sphere these mutants arise from the birth of geniuses, saints and seers, who contribute to the progress of human civilization. The condition of science in Europe also was no better in this

period (Middle Ages) than what prevailed in India. But the birth of Copernicus, Galileo, Newton, Boyle, Lavoisier and Dalton gave entirely a new turn to its course. Their ideas and thoughts imparted a fresh impetus to it. These could not, however, penetrate India until the advent and consolidation of the British rule towards the middle of the 19th century.

APPENDIX

THE PHYSICOCHEMICAL THEORIES OF THE ANCIENT HINDUS

(By B. N. Seal)

[Abridged from Seal's paper in P C Ray's *History of Hindu Chemistry*, Vol II]

I propose in this section to give a synoptic view of the physical and chemical theories of the ancient Hindus. A chronological survey, even if the materials for it were available, would be here of little account. The origins of Hindu natural philosophy in the speculations of the Brahmanas and the Upanishads, or in the mythology of the Puranas, however interesting from the standpoint of *Kultur-geschichte*, do not come within the scope of the present exposition, which relates to the result of systematic thought as directed to the phenomena and processes of Nature. I have, therefore, confined to an account of natural philosophy as expounded in the principal systems of Hindu thought. The Samkhya-Patanjala system accounts for the Universe on principles of cosmic evolution, the Vaiseshika-Nyaya lays down the methodology of science, and elaborates the concepts of mechanics, physics and chemistry The Vedanta, the Purva-Mimamsa, and, in a less degree, the Bauddha, the Jaina, and the Charvaka systems make incidental contributions on points of special interest; but their main value in this regard is critical and negative The principal authorities followed in this account,—the Vyasa Bhashya on Patanjali's Sutras, the Samhita of Charaka, the Bhashya of Prasastapada, the Varttika of Uddyotakara, and the Vrihat Samhita of Varahamihira,—all centre round the Hindu Renaissance, the beginnings of the anti-Buddhist reaction, in the fourth, fifth and the sixth centuries of the Christian era Whenever I have made use of later authors, e g. Kumarila,



Sankara, Sridhara, Vachaspati, Udayana, Bhaskara, Jayanta, Varvara, Raghunatha, Vijnanabhikshu, etc, I have taken care to see (except where the opposite is expressly mentioned) that no idea is surreptitiously introduced, which is not explicitly contained in the earlier authors.

The Samkhya-Patanjala System

This system possesses an unique interest in the history of thought as embodying the earliest clear and comprehensive account of the process of cosmic evolution, viewed not as a mere metaphysical speculation, but as a scientific principle, based on the conservation, the transformation, and the dissipation of energy.

Prakriti—the Ultimate Ground

The manifested world is traced in the Samkhya to an unmanifested ground, *Prakriti*, which is conceived as formless and undifferentiated, limitless and ubiquitous, indestructible and undecaying, ungrounded and uncontrolled, without beginning and without end. But the unity of *Prakriti* is mere abstraction; it is in reality an undifferentiated manifold, and indeterminate infinite continuum of infinitesimal Reals These Reals, termed *gunas*, may by another abstraction be classed under three heads: (1) *sattva*, the Essence, which manifests itself in a phenomenon, and which is characterised by this tendency to manifestation, in otherwords, which serves as the medium for the reflection of Intelligence; (2) *rajas*, Energy, that which is efficient in a phenomenon, and is characterised by a tendency to do work, or overcome resistance; and (3) *tamas*, mass or inertia, which counteracts the tendency of *rajas* to do work, and of *sattva* to conscious manifestation.

The ultimate factors of the universe, then, are: (1) Essence or Intelligence-stuff, (2) Energy, and (3) Matter, characterised by mass or inertia.

These *gunas* are conceived to be Reals, substantive entities,—not, however, as self-subsistent or independent entities (*pradhan*),—but as interdependent moments in every Real or substantive Existence.

Even Energy is substantive in this sense. The infinitesimals of Energy do not possess inertia or gravity, and are not therefore material, but they possess quantum and extensity (*pariman—parichchhinnattva*).

The very nature of Energy is to do work, to overcome resistance, to produce motion. All Energy is, therefore, ultimately kinetic. Even potential Energy (*anutbhutabritti sakti*, Energy whose action is unmanifested) is only the Energy of motion in imperceptible forms.

THE ORIGINAL CONSTITUENTS AND THEIR INTERACTION

Every phenomenon, it has been expressed, consists of a three-fold *arche*, intelligible Essence, Energy and Mass. In intimate union these enter into things as essential constitutive factors. The Essence of a thing (*sattva*) is that by which it manifests itself to intelligence, and nothing exists without such manifestation in the universe of consciousness But the Essence is only one of these moments. It does not possess mass or gravity, it neither offers resistance, nor does work. Next there is the element of *tamas*, mass, inertia, matter-stuff, which offers resistance to motion, as well as to conscious reflection.

But the intelligence-stuff and matter-stuff cannot do any work, and are devoid of productive activity in themselves All work comes from *rajas*, the principle of Energy, which overcomes the resistance of matter, and supplies even Intelligence with the Energy which it requires for its own work of conscious regulation and adaptation

The *gunas* are always uniting, separating, uniting again. Everything in the world results from their peculiar arrangement and combination Varying quantities of Essence, Energy

and Mass, in varied groupings, act on one another, and through their mutual interaction and interdependence evolve from the indefinite or qualitatively indeterminate to the definite or qualitatively determinate. But though co-operating to produce the world of effects, these diverse moments with diverse tendencies never coalesce. In the phenomenal product whatever Energy there is, is due to the element of *rajas*, and *rajas* alone ; all matter, resistance, stability is due to *tamas* , and all conscious manifestation to *sattva*

The nature of the interaction is peculiar In order that there may be evolution with transformation of Energy, there must be a disturbance of equilibrium, a preponderance of either Energy or Mass-resistance or Essence over the other moments The particular *guna*, which happens to be predominant in any phenomenon, becomes manifest in that phenomenon, and the others become latent, though their presence is inferred by their effect. For example, in any material system at rest, the Mass is patent, the Energy latent, and the conscious manifestation sub-latent. In a moving body the *rajas*, Energy, is predominant (kinetic), while the Mass, or rather the Resistance it offers, is overcome. In the volitional consciousness accompanied with movement, the transformation of Energy (or work done by *rajas*) goes hand in hand with the predominance of the conscious manifestation, while the matter-stuff or Mass, though latent, is to be inferred from the resistance overcome.

The Starting Point

The starting point in the cosmic history is a condition of equilibrium or equipoise consisting in a uniform diffusion of the Reals. The tendencies to conscious manifestation, as well as the powers of doing work, are exactly counterbalanced by the resistance of the inertia or Mass. The process of cosmic evolution (*parinam*) is under arrest.

BEGINNING OF EVOLUTION

The transcendental (non-mechanical) influence of the *Purusha* (the Absolute) puts an end to the arrest, and initiates the process of creation. Evolution begins with the disturbance of the original equilibrium. How this is mechanically brought about is not very clear. A modern expounder of the Samkhya supposes that the particles of the *sattva, rajas,* and *tamas* possess a natural affinity for other particles of their own class, and that when the transcendental influence of the *Purusha* ends the state of arrest, the affinity comes into play, breaks up the uniform diffusion, and leads to unequal aggregation, and therefore, to the relative preponderance of one or more of the three *gunas* over the others. Thus commences formative combination among the Reals, and consequent productive activity.

FORMATION OF WHOLES OR SYSTEMS—COLLOCATION OF REALS

Creative transformation accompanied with evolution of motion (*parispanda*) and work (*kriya*) done by Energy cannot take place without a peculiar collocation of the Reals (*gunas*) To form wholes or systems (*samudaya*) it is essential that one *guna* should for the moment be preponderant, and the others co-operant. And this cannot be without an unequal aggregation which overthrows the original equilibrium,—in other words, without unequal forces or stresses coming into play in different parts of the system.

THE FORMULA OF EVOLUTION

Differentiation in Integration—Evolution (*parinam*) in its formal aspect is defined as differentiation in the integrated. In other words, the process of Evolution consists in the development of the differentiated within the undifferentiated,

of the determinate within the indeterminate, of the coherent within the incoherent. The evolutionary series is subject to a definite law which it cannot overstep. The order of succession is not from the whole to parts, nor from parts to the whole,—but ever from a relatively less differentiated, less determinate, less coherent whole to relatively more differentiated, more determinate, more coherent whole. On the Samkhya view, increasing differentiation proceeds *pari pasu* with increasing integration within the evolving whole, so that by this two-fold process what was an incoherent, indeterminate, homogeneous whole evolves into a coherent, determinate, heterogeneous whole

The different stages in the order of cosmic evolution are characterised as follows :—

(1) The inconceivable, the unknowable, the formless, the indistinguishable *Prakriti*, or the Reals in a state of equilibrium.

(2) The knowable cosmic matter of Experience, or stuff of consciousness,—comprising *Mahat*, the intelligible Essence of the cosmos, evolved by differentiation and integration within the formless, characterless, inconceivable *Prakriti*

(3) Individuated but still indeterminate stuff, bifurcating into two series—Subject-experience and Object-experience, evolved from the previous stage of *Mahat* The Subject series representing individuated, indeterminate mind-stuff, empirical Ego (*Ahankara*), and the Object series representing individuated but indeterminate matter-stuff (subtile material potencies, *Tanmatra*).

(4) In the Subject-experience series the empirical Ego evolves by further differentiation and integration into determinate sensory- and motor-stuff. In the Object-experience series a corresponding atomic matter-stuff is evolved in a determinate form from the subtile material potencies or *Tanmatra*.

(5) Coherent and integrated matter-stuff evolved from the determinate atomic matter-stuff of the previous stage

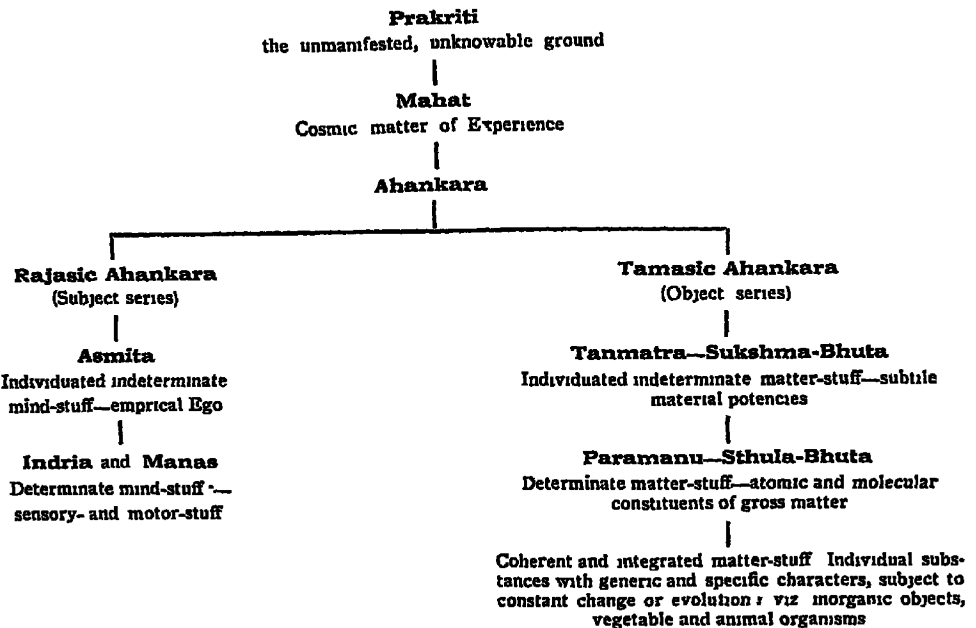
These constitute individual substances, characterised by generic and specific properties, which, however, are not rigidly fixed, but fluent, being subject to a three-fold change, and constantly evolving.

(6) The cosmic series moves on in ascending stages of unstable equilibrium until the reverse course of equilibriation and dissipation of Energy, constantly accompanying the evolution and transformation of Energy, completes the disintegration of the universe into its original unmanifested ground, the unknowable *Prakriti*.

The order of Cosmic Evolution according to Samkhya is shown overleaf.

THE CONSERVATION OF ENERGY (AND OF MASS)—THE TRANSFORMATION OF ENERGY

The *gunas* (Reals), though assuming an infinite diversity of forms and powers, can neither be created nor destroyed. The totality of the Mass (*tamas*) as well as of Energy (*rajas*) remains constant, if we take account both of the manifested and the unmanifested, the actual and the potential But the individual products of the evolutionary process, the concrete phenomenal modes resulting from the combined action of the original Mass, Energy and Essence, are subject to addition and subtraction, growth and decay, which are only due to changes of collocation, and consequent changes of state from the potential to the actual, (in other words, from the future to the present, and from the present to the past, in a time series)—changes which are illusorily ascribed to the Reals themselves The different collocations of Mass and Energy give birth to the diverse powers of things, the various forms of Energy which may be classed as like and unlike; indeed, the course of Evolution from the Reals conforms to a fixed law, not only as regards the order of succession, but also as regards the appearance (and mutual relations) of like and unlike Energies. And this transformation is constantly going on,—the course of Evolution is not arrested for a moment.


The Order of Cosmic Evolution
Prakriti
the unmanifested, unknowable ground
Mahat
Cosmic matter of Experience
Ahankara
Rajasic Ahankara
(Subject series)
Asmita
Individuated indeterminate mind-stuff—emprical Ego
Indria and Manas
Determinate mind-stuff—sensory- and motor-stuff
Tamasic Ahankara
(Object series)
Tanmatra—Sukshma-Bhuta
Individuated indeterminate matter-stuff—subtile material potencies
Paramanu—Sthula-Bhuta
Determinate matter-stuff—atomic and molecular constituents of gross matter
Coherent and integrated matter-stuff Individual substances with generic and specific characters, subject to constant change or evolution : viz inorganic objects, vegetable and animal organisms

THE DOCTRINE OF CAUSATION, A COROLLARY FROM THE CONSERVATION AND TRANSFORMATION OF ENERGY—THE PRINCIPLE OF COLLOCATION—THE STORING UP AND THE LIBERATION OF ENERGY

The Samkhya view of causation follows at once as a corollary from this doctrine of the conservation and transformation of Energy. As the total Energy remains the same, while the world is constantly evolving, cause and effect are only more or less evolved forms of the same ultimate Energy. The sum of effects exists in the sum of causes in a potential (or unevolved) form. The grouping or collocation alone changes, and this brings on the manifestation of the latent powers of the *gunas* but without creation of anything new. What is called the (material) cause, or sum of material causes, is only the power, which is efficient in the production, or rather the vehicle of the power. This power is the unmanifested (potential) form of the Energy set free in the effect. But the concomitant conditions are necessary to call forth the so-called material cause into activity. When the favourable combination or co-operation of concomitants is wanting, there is no manifestation of the effect The question is—what is the aid which the concomitant conditions render in the determination (and production) of the effect, existing in potency in the material cause ? First, there is the merely mechanical view as illustrated by some commonplace examples, e.g., the manifestation of the figure of the statue in the marble block by the causal efficiency of the sculptor's art, or of the oil in the sesamum by pressing, or of the grain of rice out of the paddy by the process of husking. In these cases the manifestation of an effect is only its passage from potentiality to actuality, a stadium in the process of evolution from possible (future) existence to actual (present) existence; and the concomitant condition or efficient cause, the sculptor's chiselling, the pressing, the husking, is a sort of mechanical or instrumental help to this passage or transition.

These mechanical examples of the Kapila-Samkhya have the merit of simplicity, but the Patanjali-Samkhya explains

causation on the basis of the conservation and transformation of Energy, advancing it as the liberation of potential Energy, existing stored up in a *guna* collocation (the sum of material causes). The liberation follows on the action of the proximate efficient cause or concomitant condition.

The causal operation of concomitant conditions (efficient causes) lies only in this that they supply a physical stimulus, which liberates the potential Energy stored up in a given collocation Everything in the phenomenal world is but a special collocation of the ultimate Reals (Energy, Mass and Essence). The sum of (material) causes potentially contains the Energy manifested in the sum of effects; and in the passage from potency to actualisation, the effectuating condition (the concomitant cause), when it is itself accomplished, is only a step in the evolutionary series, which adds a specific stimulus, and renders determinate that which was previously indeterminate. When the effectuating condition is added to the sum of material conditions in a given collocation, all that happens is that a stimulus is imparted, which removes the arrest, disturbs the relatively stable equilibrium, and brings on a liberation of Energy together with a fresh collocation

Describing the production of bodies (organic vehicles) for individual souls, out of matter of *Prakriti*, under the influence of their merit and demerit, as concomitant conditions, Patanjali points out that non-material concomitants like merit and demerit do not supply any moving force of Energy to the sum of material conditions, but only remove the arrest (the state of relatively stable equilibrium) in a given collocation, even as the owner of a field removes the barrier *in flooding his* field from a reservoir of water. This description is intended to represent the superphysical influence of non-material concomitants (or causes) like volition, merit, demerit, etc., but the causal operation of a material concomitant condition is essentially the same;—there is the same reservoir of stored-up Energy in a given collocation—the same condition of arrest or relatively stable equilibrium—the same liberation of the

stored-up potential Energy which flows along the line of least resistance ;—the only difference being that in the case of material concomitants the stimulus which removes the arrest is physical, instead of being transcendental as in the case of non-material causes like will, merit, demerit, etc

The Vyasa-bhashya helps us to a clear mental representation of the details of this process. As the owner of many fields can irrigate, from a field which is already flooded, others of the same or lower level, without forcing the water thereto with his hands, and merely by making an opening in the barrier or dyke, on which the waters rush in by their own force ;—or further, as the same person cannot force these waters, or the earthy matters held in solution therein, into the roots of the rice plants, but only removes the obstructive grasses and weeds, on which the fluids of their own power enter the roots ;—such is the action of an effectuating condition added to a sum of material causes or conditions.

Chain of Causation—Fixed Order

The order of Evolution with the transformation of the Energy follows a definite law. The unalterable chain of causes and effects in the phenomenal world illustrates this fixed order But though the cosmic order is one and fixed, it comprehends diverse series arising from different combinations of the original *gunas*, which constitute sub-ordinate or particular laws of cause and effect.

What we call the qualities of things are only modes of Energy acting in those collocations And these various energies are sometimes actual (kinetic), sometimes potential, rising to actuality, and sometimes sublatent, subsiding from actuality into sublatency. In fact, the original Energy is one and ubiquitous and everything, therefore, exists in everything else potentially without prejudice to the generic and specific differences of things. Inorganic matter, vegetable organisms and [illegible] organisms are essentially and ultimately one, so far [illegible]

and Energy are concerned; but the varied forms of Energy and the generic and specific qualities (or properties) of things, which are but modes of Energy, follow a definite unalterable law in the order of their appearance and succession, under conditions of space, time, mode and causality, and hence all effects do not manifest themselves at once.

TIME, SPACE AND THE CAUSAL SERIES

A *Tanmatra* (infra-atomic particle of subtile matter) is conceived by our understanding to stand in three relations:— (1) position in space, (2) position in the time series and (3) position in the causal series.

These three relations are the work of the intuitive stage of knowledge as opposed to the conceptual. But this is not the pure relationless intuition of Reality which may be termed intellectual intuition, but the intuition that imposes its forms on the Real substrate, or, in other words, empirical intuition.

Infinite Time is a non-entity objectively considered, being only a construction of the Understanding based on the relation of antecedence and sequence in which the members of the phenomenal series are intuited to stand to one another. These phenomenal changes, as intuited by us in the empirical consciousness, fall into a series, which the Understanding conceives as order in Time The Time-series, then, is a *schema* of the Understanding for representing the course of Evolution. The *schema* of the Understanding supervenes on the phenomenal world as order in time, and hence in the empirical consciousness the Time-series appears to have an objective reality, and to form a continuum. As there is an ultimate and irreducible unit of extensive quantity in the *gunas* or infinitesimal Reals of *Prakriti*, which are without constituent parts, so the moment may be conceived as the ultimate and irreducible unit of this time-continuum as represented in the empirical consciousness A moment, therefore, cannot be thought of as containing any parts standing in the

relation of antecedence and sequence. If change is represented by the Time-series, a moment as the unit of time may be supposed to represent the unit of change. Now all physical changes may be reduced to the motion of atoms in space; we may therefore define the moment as representing the ultimate unit of such change—viz, the (instantaneous) transit of an atom (or rather a *tanmatra*) from one point in Space to the next succeeding point. Even an atom has constituent parts (the *tanmatras*), and hence an atom must take more than one moment to change its position. The motion of that which is absolutely simple and without parts from one point in Space to the next must be instantaneous, and conceived as the absolute unit of change (and, therefore, of time). If this is held to be an irreducible absolute unit, it will follow that what we represent as the time continuum is really discrete. Time is of one dimension. Two moments cannot co-exist. Neither does any series of moments exist in reality. Order in Time is nothing but the relation of antecedence and sequence, between the moment that is, and the moment that went just before. But only one moment, the present, exists. The future and the past have no meaning, apart from potential and sublatent phenomena. One kind of transformation, to which a thing is subject, is that it changes from the potential to the actual, and from the actual to the sublatent. This may be called the change of mark, as opposed to change of quality and the change due to duration or lapse of time. The present is the mark of actuality,—the future, the mark of potentiality,—and the past of sublatency,—in a phenomenon. Only one single moment is actual, and the whole Universe evolves in that one single moment. The rest is but potential or sublatent.

Vijnana-bhikshu points out that this does not amount to a denial of Time. It means that Time has no real (or objective) existence apart from the 'moment'. But the latter is real, being identical with the unit of change in phenomena. But even this is real only for our empirical (relative) consciousness, which

intuits the relation of antecedence and sequence into the evolving Reals (*gunas*), in the stage of 'empirical intuition'. The 'intellectual' intuition, on the other hand, apprehends the Reals as they are, without the empirical imported relations of Space, Time and Causality.

SPACE AS EXTENSION AND SPACE AS POSITION

Space must be distinguished as *desa* (locus or rather extension) and *dik* (relative position). Space (*dik*), as the totality of position, or as an order of co-existent points, is wholly relative to the understanding, like order in time, being constructed on the basis of relations of position intuited by our empirical (or relative) consciousness. But there is this difference between the Space-order and Time-order .—there is no unit of Space as position (*dik*), though we may conceive a unit of Time, viz, the moment regarded as the unit of change in the phenomenal or causal series Spatial position (*dik*) results only from the different relations in which the all-pervasive *akasa* stands to the various finite (or bounded) objects On the other hand, Space as extension or locus of a finite body, *desa*, has an ultimate unit, being analysable into the infinitesimal extensive quantity inherent in the Reals (*gunas*) of *Prakriti*

THE CAUSAL SERIES

The relation of Cause and Effect has been already explained. It only remains to add that the category of causality is mediated through the *schema* of order in Time. The Empirical Intuition first superimposes relations of antecedence and sequence on changing phenomena (the evolving *gunas* or Reals), and the Understanding out of these relations creates order in Time. The Empirical Intuition then intuits the phenomenal series of transformations of Energy in this Time-order and, in so doing, imports the relation of cause and effect into the course of Nature.

THE DISSIPATION OF ENERGY (AND OF MASS)—THEIR DISSOLUTION INTO THE FORMLESS PRAKRITI

Cosmic Evolution is a two-fold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic. In one aspect, there is the aggregation (unequal aggregation) of Mass and Energy, with consequent transformation of Energy, resulting in the creation of inorganic as well as organic matter, and the genesis of worlds. The successive steps of this process may be described as (1) unequal aggregation with storing-up of Energy in a certain collocation, under a state of arrest (i.e., in a state of relatively stable equilibrium), (2) a stimulus removing the arrest, and disturbing the equilibrium, and (3) liberation of the Energy, moving on to a fresh collocation, fresh aggregation, arrest and equilibrium. The process of the world thus moves on from equilibrium to equilibrium, and the result of that process is the development of a coherent, determinate, heterogeneous whole in what is essentially an incoherent, indeterminate, homogeneous whole.

But there is a second aspect of this evolutionary process. Unequal aggregations are unstable, there is a constant tendency in things to go back to the original stable equilibrium, the state of uniform equal diffusion of Reals (*cf.* Entropy). This process is called the resolution of like to like, consisting in assimilation and dissipation, and being the exact opposite of the process of "differentiation in the integrated" which has evolved the Cosmos The collocations of Mass, Energy and Essence are always breaking up, and the Energy as well as the Mass, however slowly, however imperceptibly, are being dissipated, i e., dissolved into the original formless *Prakriti*, a state of permanent equilibrium and arrest, from which there is and can be no return, except under the transcendental influence of the Absolute at the commencement of a new creative cycle. Not that there is a destruction of Mass or Energy, but a dissipation or dissolution into a condition of equal uniform diffusion from which there is no return This

is not the phenomenon of kinetic Energy disappearing and becoming potential or sublatent, for in such cases there is restitution or reconversion by natural means. When this reverse current of assimilation (and dissipation) prevails over the current of dissimilation (and integration), the Universe will disintegrate more and more, until it disappears in the formless *Prakriti*, its unknowable source and ground.

THE EVOLUTION OF MATTER (TANMATRIC CREATION)

The ultimate constitution of Matter is a question of the profoundest interest in the Samkhya-Patanjala system Three stages clearly stand out in the genesis of matter .—(1) the original infinitesimal units of Mass or inertia, absolutely homogeneous and ubiquitous, on which Energy does work, when the original equilibrium comes to an end,—(*bhutadi*) ; (2) the infra-atomic unit potentials, charged with different kinds of Energy, which result from the action of Energy on the original units of Mass,—(*tanmatra*), and (3) the five different classes of atoms, the minutest divisions, of which gross matter is capable, but which are themselves complex *tanmatric* systems,—(*sthula-bhuta paramanu*)

The first stadium *bhutadi* is absolutely homogeneous and absolutely inert, being devoid of all physical and chemical characters except quantum or mass (*parichchhinnatva, pariman*) and this admits neither of addition nor of subtraction, can neither be created nor destroyed The second stadium *tanmatra* represents subtile matter, vibratory, impingent, radiant, etc, instinct with potential energy These potentials arise from the unequal aggregations of the original mass-units in different proportions and collocations with an unequal distribution of the original Energy (*rajas*). The *tanmatras* possess something more than quantum of Mass and Energy. They possess physical characters, some of them penetrability, others, powers of impact or pressure, others, radiant heat, others again capability of viscous and cohesive attraction In intimate relation to these physical characters they also possess the potentials of

the energies represented by sound, touch, colour, taste and smell, but being subtile matter they are devoid of the peculiar forms which these potentials assume in particles of gross matter like the atoms and their aggregates. In other words, the potentials lodged in subtile matter must undergo peculiar transformations by new groupings or collocations to be classed among sensory stimuli,—gross matter being supposed to be matter endowed with properties of the class of sensory stimuli, though in the minutest particles thereof the sensory stimuli may be infra-sensible.

The *tanmatras*, then, are infra-atomic particles charged with specific potential energies,—first, the potential of the sound stimulus is lodged in one class of particles, *tanmatras* which possess the physical energy of vibration and serve to form the radicle of the ether atom (*akasa paramanu*); then the potential of the tactile stimulus is lodged in another class of *tanmatras*, particles which possess the physical energy of impact or mechanical pressure in addition to that of vibration, and serve to form the radicle of the gas atom (*vayu paramanu*); next, the potential of the colour stimulus is lodged in a third class of *tanmatras*, particles which are charged with the energy of radiant heat and light in addition to those of impact and vibration, and serve to form the nucleus of the light-and-heat corpuscle (*teja paramanu*), then the potential of the taste stimulus is lodged in other *tanmatras*, particles which possess the energy of viscous attraction, in addition to those of heat, impact and vibration, and which afterwards develop into the atom of water (*ap paramanu*); and lastly, the potential of the smell stimulus is lodged in a further class of *tanmatras*, particles which are charged with the energy of cohesive attraction, heat, impact and vibration, and which serve to form the radicle of the earth-atom (*kshiti paramanu*).

Before explaining the genesis of atoms, it is necessary to say something about *akasa*, which is the link between the infra-atomic particles (*tanmatras*) and atoms (*paramanus*).

Akasa corresponds in some respects to the ether of the physicists, and in others to what may be called proto-atom (*protyle*) In one respect *akasa* is all pervasive and devoid of the property of impenetrability which characterises even the infra-atomic potential units (*tanmatras*) In another aspect, *akasa* is described as having originated out of the mass or inertia in *Prakriti* (*bhutadi*), when the latter became charged with the first potential vibration (the sound-potential). Vijnanabhikshu in the Yoga-Vartika boldly tackles the difficulty. *Akasa*, he explains, has two forms; original and derivative, non-atomic and atomic. The original *akasa* is the undifferentiated formless *tamas* (mass in *Prakriti*, matter rudiment—*bhutadi*) which is devoid of all potentials, and is merely the all-pervasive seat or vehicle of the ubiquitous original Energy (*rajas*). This *akasa* must not be confounded with vacuum, which is merely negative, though it must be conceived as all pervasive, occupying the same space as the various forms of gross matter, and, therefore, devoid of the property of impenetrability which characterises atomic matter But when the original equilibrium comes to an end, unequal aggregations form collocations in different groups and proportions of the three *gunas*. The transformation of Energy now begins,—working on a collocation of Mass (with Essence); it first gives rise to the sound-potential, and the atomic *akasa* (proto-atom, *protyle*) is but an integration of the original unit of mass charged with this vibration-potential This vibratory (or rather rotary) ether atom is integrated, or limited (*parichchhinna*), and as such cannot occupy the same space with other (subsequently integrated) atoms But this proto-atomic integration of *akasa* is formed everywhere, and itself residing in the ubiquitous non-atomic *akasa* forms the universal medium in which air or gas atoms, light-and-heat-corpuscles, and other atoms move and float about.

The Genesis of the Infra-atomic Unit Potentials (Tanmatras) and of the Atoms

The subject of the genesis and the structure of the *tanmatras* and the *paramanus* was a fascinating one to

these ancient thinkers, and a wide divergence of views prevailed. I will give here several typical views :—those of the Vishnu Purana, Parasara, Patanjali and a certain School of Vedantists.

1 A famous passage in the Vishnu Purana explains the genesis and the structure of the *tanmatras* and of the *bhutas* (*paramanus*) in the following manner :—

The first *tanmatra* originated from the rudiment-matter (*bhutadi*), the individuated but still indeterminate potential-less Mass in *Prakriti*, under the action of Energy by a process of disintegration and emanation in the menstruum, or surrounding medium of the unindividuated Cosmic Mass (*mahat*)

This first subtile matter, the first result of 'Mass-disintegration' and Energy-transformation, is charged with the sound-potential, the potential of vibration or oscillation. It is called the sound-potential (*sabda-tanmatra*).

This is typical of the genesis (and structure) of the *tanmatras* (kinds of subtile matter). In each of the remaining cases, an atomic Mass charged with actual specific energies disintegrates and emanates, and thus evolves a form of subtile matter (a kind of *tanmatra*) under the action of Energy, and always in the same menstruum or surrounding medium, —that of *bhutadi*, the super-subtile. Each kind of subtile matter becomes charged with a new potential in addition to the potentials already evolved. The genesis of an atom, *bhuta-paramanu* is a quite different process. Here the unit potential (*tanmatra*) receives an accretion of Mass, and by a sort of condensation and collocation evolves an atom (*bhuta-paramanu*).

The genesis and structure of the *tanmatras* and the *bhuta-paramanus* are worked out below :—

1. The super-subtile individuated Mass (rudiment-matter —*bhutadi*), under the action of the original Energy (*rajas*), disintegrates and emanates in the menstruum or surrounding medium of *mahat*, cosmic super-subtile Mass, and evolves a form of subtile-matter (*tanmatra*), which becomes charged with the

sound-potential (vibration-potential—*parispanda*), and is called the unit of sound-potential (*sabda-tanmatra*).

2 This subtile matter, the Mass, charged with sound-potential, receives an accretion of Mass from the rudiment of matter (*bhutadi*) and by condensation and collocation evolves the *akasa bhuta*, the atomic *akasa*, the proto-atom charged with the specific energy of the sound stimulus (actual vibratory motion).

3. This proto-atom, the atomic *akasa*, charged with its actual specific energy, again disintegrates and emanates, under the action of the original Energy and in the menstruum of the rudiment-matter (super-subtile Mass), and thus evolves another kind of subtile matter (*tanmatra*) which becomes charged with the touch-potential (the potential of impact or mechanical pressure), in addition to the sound-potential, and is called the unit of touch-potential (*sparsha-tanmatra*).

4. Next, this subtile matter, the mass charged with touch-(and sound-) potential, i.e., with the potentials of vibration and impact, receives an accretion of mass again from the rudiment-matter (*bhutadi*), and by condensation and collocation evolves the *vayu bhuta*, a kind of gaseous matter or air, of which the atoms are charged with the actual specific energy of the touch-stimulus, i.e., with the actual energy of impact in addition to the actual energy of vibratory motion.

5. Next, the atom of *vayu*, so charged with the actual specific energy of impact and vibration, again disintegrates and emanates, under the action of the original Energy and in the same menstruum or surrounding medium of the rudiment-matter (*bhutadi*), and thus evolves another kind of subtile matter (*tanmatra*), which becomes charged with the heat-potential (heat-and-light-potential), in addition to the impact-potential and the vibration-potential, and is called the unit of colour-potential (*rupa-tanmatra*).

6. Now this subtile matter, this radiant matter, charged with light-and-heat-potential, and also with impact-and

vibration-potential, receives an accretion of Mass again from the rudiment-matter (*bhutadi*), and by condensation and collocation evolves the *tejas bhuta*, the light-and-heat-corpuscle, which is charged with the specific energy of the colour-stimulus, i e., radiates actual heat and light in addition to manifesting the energy of impact and of vibration.

7. Next, this atom or light-and-heat-corpuscle disintegrates, and emanates as before a form of subtile matter charged with the taste-potential (*rasa-tanmatra*), in addition to the three potentials already generated, and also with the physical potential of viscous attraction.

8. This subtile matter charged with the taste-potential and with the potential of viscous attraction condenses and collocates as before into the water-atom, which manifests the actual specific energies of viscous attraction and the taste-stimulus.

9. The viscous water-atom charged with the actual specific energy of the taste-stimulus disintegrates, and emanates as before a form of subtile matter charged with the smell-potential, in addition to the four potentials already generated, and also with the potential of cohesive attraction.

10. This subtile matter charged with the smell-potential and with the potential of cohesive attraction condenses and collocates as before into the earth-atom, which manifests the actual specific energies of cohesive attraction and the smell-stimulus.

Vijnana-bhikshu in the Yoga-Vartika briefly summarises the Vishnu Purana process as follows.—

Bhutadi as radicle in conjunction with *mahat* produces the sound-potential, which as radicle in conjunction with *bhutadi* produces *akasa*, which as radicle in conjunction with *bhutadi* produces the touch-potential, which as radicle in conjunction with *bhutadi* produces *vayu*, which as radicle in conjunction with *bhutadi* produces the colour-potential, which as radicle in conjunction with *bhutadi* produces *tejas*, and so on.

11. A famous passage in Parasara takes another view of the genesis and structure of the *tanmatras* and the *bhuta-paramanus.*

The *tanmatras* originate from one another in one linear series, and each *bhuta* originates in a separate line from its own *tanmatra* :

Bhutadi

|

Sabda-tanmatra— (Sound-tanmatra)—as a radicle or centre encircled by **Bhutadi** generates **Akasa.**

|

Sparsa-tanmatra— (Touch-tanmatra)—as a radicle or centre encircled by Sound-tanmatra with **Akasa**-atom as a help generates **Vayu.**

|

Rupa-tanmatra— (Colour-tanmatra)—as a radicle or centre encircled by Sound-tanmatra with **Vayu-atom** as a help generates **Tejas.**

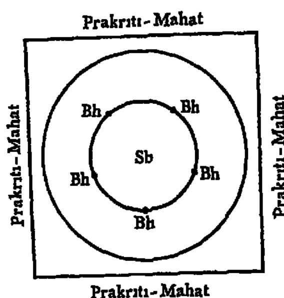
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Rasa-tanmatra— (Taste-tanmatra)—as a radicle or centre encircled by Colour-tanmatra with **Tejas-atom** as a help generates **Ap.**

|

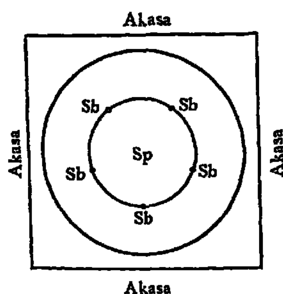
Gandha-tanmatra— (Smell-tanmatra)—as a radicle or centre encircled by Taste-tanmatra with **Ap**-atom as a help generates **Prithivi.**

Thus an atom of *akasa* has the structure given below



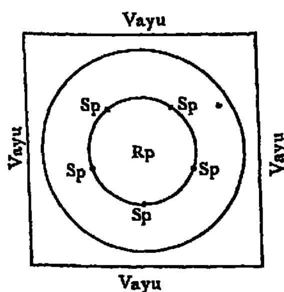
Sb = Sabda-tanmatra
Bh = Bhutadi

An atom of *vayu* is constituted as follows



Sp = Sparsa-tanmatra
(impact-potential).

An atom of *tejas*, heat-and-light-corpuscle, has the following structure .



Rp = Rupa-tanmatra
(light-potential).

In the language of chemistry, an atom of *vayu* may be regarded as generated from the impact *tanmatra* as a radicle in the menstruum of vibration-*tanmatra*, with *akasa*-atoms as a catalytic agent.

A certain school of Vedantists gives, on the other hand, a slight variation of the above view. Their scheme may be represented as follows:

A *bhuta*-atom is evolved by integration (condensation and collocation) from the corresponding *tanmatra* (subtile matter) The *tanmatras* again evolve from one another in a lineal series as in Parasara's view described above. But the process of this generation is somewhat more complex. A *tanmatra* first disintegrates and emanates in a surrounding medium (a menstruum) of the *tanmatra* just preceding it in the order of genesis, and, with the help of its own *sthula bhuta* as a sort of catalyst, generates the *tanmatra*, next in order e g., the infra-atomic impact particles (*sparsa-tanmatra*) disintegrate or emanate in a surrounding atmosphere of the vibratory subtile matter (*sabda-tanmatra*), and then with the help of their own atomic integration *vayu* (gas) generate the *tanmatra* next in order, the subtile matter of radiant light-and-heat (*tejas*)

III. *Patanjali's View.*

(a) The order of genesis of various forms of subtile matter (potentials) :—

(1) *Bhutadi*, the rudiment-matter, original mass, acted on by *rajas (Energy)*, produces the sound-potential (vibration-potential)

(2) This subtile vibration-potential, as a radicle, with accretion of rudiment-matter *(bhutadi)*, condensing and collocating, and acted on by *rajas*, generates the subtile touch-potential (impact-potential), which is impingent as well as vibratory (oscillating)

(3) This subtile impact-potential again, as a radicle, with accretion of rudiment-matter (*bhutadi*), condensing and collocating, and acted on by *rajas*, generates the subtile light-and-heat-potential, which radiates light and heat, in addition to being impingent and vibratory.

(4) Next, the light-and-heat-potential, as a radicle, with accretion of rudiment-matter (*bhutadi*), condensing and collocating as before, generates the subtile taste-potential, which is charged with the potential of taste-energy, and of viscous attraction, in addition to being vibratory, impingent and radiant.

(5) Lastly, the subtile taste-potential as a radicle, with accretion of rudiment-matter as before, condensing and collocating, generates the subtile smell-potential, which is charged with the potential of the smell-energy, and also of cohesive attraction, in addition to being vibratory, impingent and radiant.

(b) The order of genesis of the *bhuta paramanus* (forms of atomic matter),—the five classes of atoms, is given as follows.—

(1) The sound-potential, subtile matter, with accretion of rudiment-matter (*bhutadi*) generates the *akasa*-atom

(2) The touch-potentials combine with the vibratory particles (sound-potential) to generate the *vayu*-atom

(3) The light-and-heat-potentials combine with the touch-potentials and sound-potentials (i e., with impact particles and vibratory particles) to produce the *tejas*-atom.

(4) The taste-potentials combine with light-and-heat-potentials, touch-potentials and sound-potentials (i.e., with radiant, impingent and vibratory particles) to generate the *ap*-atom.

(5) The smell-potentials combine with the preceding potentials (i e, with particles of taste-energy and with radiant, impingent and vibratory particles) to generate the *kshiti*-atom.

The *akasa*-atom possesses penetrability, the *vayu*-atom impact or mechanical pressure, the *tejas*-atom, radiant heat-and-light, the *ap*-atom, viscous attraction, and the *kshiti*-atom, cohesive attraction.

Vijnana-bhikshu, in one passage, gives the following scheme of the genesis of the *bhutas* :—

A radicle of sound-potential with rudiment-matter gives *akasa*-atom, a radicle of touch-potential with *akasa*-atom gives *vayu*-atom, a radicle of light-and-heat-potential with *vayu*-atom gives *tejas*-atom, a radicle of taste-potential with *tejas*-atom gives *ap*-atom, a radicle of smell-potential with *ap*-atom gives *kshiti*-atom.

On this view, an atom of *akasa* = Bh (Sb), of *vayu* = [Bh (Sb)] (Sp), of *teajs* = [Bh (Sb)] (Sp) (Rp); where Bh = *Bhutadi*, Sb = *Sabda-tanmatra*, Sp = *Sparsa tanmatra*, Rp = *Rupa-tanmatra*.

BHUTAS AND PARAMANUS—COSMOGENESIS AND ITS SUCCESSIVE STAGES

The five *bhutas* stand for a classification of substances on the basis of their generic properties resulting, as the Samkhyas hold, from the structural type of their constituent atoms—a classification more physical than chemical, or properly speaking chemico-physical, unlike the purely chemical classification of the so-called elements of modern chemistry. A *paramanu*, again, is a type of atom corresponding to each *bhuta* class, and indeed one and the same kind of *paramanu* may comprehend atoms of different masses, if only these would agree in their structural type

Cosmogenesis—(a bird's-eye view) —Out of the all pervasive rudiment-matter (*bhutadi*) appeared *akasa* (ether), first as a *tanmatra* (subtile matter) charged with the potential energy of sound (vibration-potential), and then as an atomic integration of a *mono-tanmatric* structure (the *akasa*-atom),

also ubiquitous and all-enveloping. In the next stage we find a new kind of *tanmatras*, systems of the infra-atomic vibratory particles, so arranged as to manifest a new form of energy, that of impact or mechanical pressure, and these *tanmatras* combining with the vibration-potentials (*akasa tanmatra*) produced a new kind of atom, the *di-tanmatric vayu* atom, which by aggregation formed a gaseous Envelope composed of impinging (driving) vibratory particles (*vayu*). Next appeared the third class of *tanmatras*, infra atomic systems of the impinging vibratory particles, which by their collocation developed a new form of Energy—the Energy of radiant heat-and-light. These *tanmatras*, combining with the potentials (*tanmatras*) of vibration and impact, produced a new kind of atom—the *tri-tanmatric tejas* atom, the light-and-heat-corpuscle, which by aggregation enveloped the gaseous world in huge flamas In the next stage we have the fourth class of *tanmatras*, new and complex infra-atomic systems of the radiant impinging vibratory particles, which evolved the Energy of viscous attraction as well as the potential Energy concerned in the taste-stimulus. These *tanmatras*, combining with the three previous ones, gave rise to another class of atoms, the *tetra-tanmatric ap*-atom, and the flaming gases were thus precipitated into cosmic masses of viscous fluid matters (*ap*). Finally appeared the fifth class of *tanmatras*, infra-atomic systems of the viscous radiant impinging vibratory particles, which developed new forms of Energy—the Energy of cohesive attraction, as well as the potential Energy concerned in the stimulus of smell. These *tanmatras*, uniting with the other four kinds of infra-atomic subtile particles, formed another class of atoms, the *penta-tanmatric kshiti*-atom. Thus the viscous fluid matter were condensed and transformed into the earth-*bhuta*, comprising the majority of the so-called elements of chemistry.

Examples of the different Bhutas :

1 *Akasa* :—This is ubiquitous.

2 *Vayu* :—Various substances composed of *di-tanmatric* atoms,—kinds of *vayu*—must have been formed in the gaseous envelope in the second stage of cosmic evolution out of the proto-atoms of *akasa*. But they have either suffered a fresh transformation into substances of a more complex atomic structure, or have dissipitated into the *mono-tanmatric akasa*, out of which they took their rise. The one familiar example now surviving is atmospheric air. Water vapour is but water (*ap* ;) and smoke, fumes, etc. are but earth-particles in gaseous diffusion.

3. *Tejas* :—Various classes of *tejas* corpuscles,—substances with *tri-tanmatric* atomic structure, i.e., two grades subtler than the ordinary elements of chemistry (which are of a *penta-tanmatric* structure),—are even now known.

First there is fire or the light-and-heat emitted by the burning log of wood or lamp. Now it is important to note that the flame of a burning log of wood or of an oil lamp is not pure *tejas*, a pure mass of light-and-heat-corpuscles. There is chemical union with earth-particles (particles of the hard *penta-tanmatric* substance) acted on by Energy; and then the *tejas* corpuscles, light-and-heat-particles which are latent (absorbed) therein, come forth as flame. Then there is the light of the sun and the stars, which are flaming masses of molten viscous matters or of molten earthy matters There is also the lightning, which liberates a kind of *tejas* latent in the aqueous particles and vapours, under the action of Energy, in the same way as an ordinary fire liberates the *tejas* latent in the wood or other fuel. Next, there are the stores of animal heat derived from the break-up of the nutritive material. Lastly there comes the peculiar form of the *tejas* Energy (radiant Energy), stored up in the metalliferous ores and igneous rocks, which have been formed in the subterranean heat. Here earthy matters are mixed up, but the radiant energy predominates in the composition of the metals. Aniruddha, a late Sankhya commentator, notes in reference to igneous bodies that the greater part of their mass is derived from

the *earth-bhuta*, though the *tejas* particles determine the peculiar chemical combination, which produces them; and this must also be his view of the composition of the metals.

4. *Ap* :—This viscous fluid of a *tetra-tanmatric* structure has but one pure example, viz, water, though the various organic acids, the juices of fruits and the saps of plants, are supposed to be transformations of watery radicles combined with different kinds of earthy accretions.

5. Lastly, the *earth-bhuta*, the hard full-formed matter, with its *penta-tanmatric* atoms, comprises by far the majority of of the so-called chemical elements.

The question is,—how does one and the same *bhuta*, of the same formal structure, comprise different kinds of elements, with different atomic masses and different characteristic properties ? And the answer is not far to seek. The properties of a thing are only the energies that are manifested in the particular collocations of three *gunas*,—Mass, Energy and Essence ; and a *tri-tanmatric* or a *penta-tanmatric* atom, i.e , an atom, composed of three or of five kinds of *tanmatras*, may differ from another of the same class, in respect of the number of constituent *tanmatras* of any particular kind, as also of their collocation or grouping, and, therefore, in mass as well as in generic and specific characters.

The Samkhya-Patanjala conceives the properties (or energies) of substances to result from the grouping or the quanta of the *tanmatras*, or the *gunas* themselves, and hence any radical differences in substances of the same *bhuta* class must characterise their atoms, though in an infra-sensible form In the Nyaya-Vaiseshika, on the other hand, the atoms of the same *bhuta class* are alike in themselves, homogeneous ; and the variety of substances, compounded under the same *bhuta*, is ascribed merely to the different arrangements or grouping of the atoms, and not of their components ; for, components they have none.

As a typical and familiar instance of the variety of characteristic properties (or energies) that may result from variations in accompaniment or grouping, the Samkhya-Patanjala points to the various kinds of fruit acids and juices, all originating from one and the same *bhuta* (water) with different accretions of earthy matters In the same way, though we speak of only five classes of *tanmatras* and atoms, the infinite variety of the world results from the infinitely varied collocations of the three original *gunas*, which underlie *tanmatra* and atom alike.

Size (pariman).—As to size or volume, the Samkhya accepts only two kinds,—the infinitesimal, which is also without parts, and the non-infinitesimal, which consists of parts. The latter varies from the excessively small (the so-called *anus, tanmatras* and *paramanus*) to the infinitely great (e.g , *akasa*).

The *gunas* alone are infinitesimal, with the exception of those ubiquitous ones that evolve into *akasa* atoms and Mind-stuff: all the rest of the evolved products (whether subtile or gross matter) are non-infinitesimal.

Vijnana-bhikshu notes that all the *gunas* (Reals) cannot be ubiquitous If this were the case, that disturbance of equilibrium, that unequal aggregation with unequal stress and strain, with which cosmic evolution begins, would be impossible. The *gunas*, which give rise to *akasa* and Mind-stuff, must be held to be ubiquitous, and this will suffice for the ubiquity of *Prakriti*

Chemical Analysis and Synthesis—Elements and Compounds

What then is the equivalent in the Samkhya-Patanjala of the distinction between a chemical element and a chemical compound, or is there none? Did or did not this elaborate physical analysis and classification of things lead on to a classification based on chemical analysis and chemical synthesis? These are questions of singular interest, the answer

to which will disclose some new points of view from which the ancient Hindu thinkers approached the problems of chemical physics and physical chemistry.

Aggregates may, in regard to their structure, be divided into two classes, (1) those, of which the parts are in intimate union and fusion, being lost in the whole; and (2) mechanical aggregates, or collocations of distinct and independent parts

A substance is an aggregate of the former kind, and may be divided into two classes; (1) the *bhutas* and their isomeric modifications, and (2) chemical compounds. Chemical compounds again may be subdivided into two classes, (1) those composed of atoms of the same *bhuta* class, i.e, of different isomeric modifications of the same *bhuta*, and (2) those composed of atoms of different *bhuta* classes. In the first case, there is contact between isomeric atoms, in the second case, between heterogeneous or polymeric atoms The first contact leads to intimate union: the isomeric atoms by a peculiar liberation of Energy are attracted towards one another, and being riveted as it were, form the so-called material cause of the compound product. The second kind of contact (between unlike atoms of heterogeneous *bhutas*) begins with a liberation of Energy, which breaks up each of the *bhutas*, and, taking particles (or atoms) of one as nuclei or radicles, groups particles of the rest around these radicles in a comparatively free or unattached condition. In this case, one *bhuta*, that which serves to furnish the radicles, not necessarily that which is numerically or quantitatively predominant, gets the name of "material cause", and the others, which by their collocation cause the liberation of Energy, are called "efficient causes."

But, besides these transformation of substances by 'isomeric' or 'heterogenic' (polymeric) process, ceaseless changes go on in the characters, the modality, and the states of substances—changes which are due to the unequal distribution of force (or of stress and strain,—pressure) among the *gunas*, which are in themselves constant.

Now the question is—in these mixed substances does the fusion take place by *paramanus*, or by larger masses or lumps? Now a *paramanu* is defined to be the smallest portion of any substance which exhibits the characteristic qualities of that substance,—in other words, it stands for the smallest homogeneous portion of any substance. It is not without parts and, therefore, not indivisible. It is subject to disintegration In a *bhuta* or its isomeric modification, the *paramanu*, the smallest homogeneous component particle, is unmixed, and, therefore, corresponds to the atom of modern chemistry. In a mixed substance, whether it is an isomeric or a polymeric compound, the qualities are due to the mixture, and, therefore, its *paramanu*, the smallest homogeneous particle possessing its characteristic qualities, must result from the mixture of the *paramanus* (in smaller or larger numbers as the case may be) of the component substances. The *paramanu* of a mixed substance, therefore, corresponds to what we now call molecule That the *paramanus* form molecules in forming substances, is acknowledged by the Samkhyas, as will appear from Gaudapada Even the Vaiseshikas, with their prejudice against 'polymeric' or 'heterogenic' combination, acknowledge that in 'polymeric' compounds, the different *bhuta* substances unite by their *paramanus* (or atoms), though they rigidly insist that in such cases only one atom should be regarded as the 'radicle' and the others as co-efficient causes

It is only in the mediaeval Samkhya-Patanjala that under the influence of the Nyaya-Vaiseshka a radical difference was conceived to exist between the structure (constitution) of a molecule composed of 'isomeric' atoms, and that of one composed of heterogeneous atoms In the former case, an intimate union was believed to take place, in the latter only a grouping of comparatively free or loosely attached atoms round a radicle atom, with liberation of Energy and the setting up of unequal stress and strain. At the same time, it was, of course, admitted that this distinction does not apply to the forms of subtle matter (*tanmatra*) which could unite in intimate fusion, whether homogeneous or heterogeneous.

According to the view of the earlier Samkhyas, atoms of different *bhutas* may chemically combine to form molecules of compound substances, as much as atoms of different modes of the same *bhuta*.

Chemistry in the Medical Schools of Ancient India

The prevailing schools of medicine and surgery founded by Charaka and Susruta (circa 1st century A.D.), which were based on the Samkhya teaching with a methodology derived from the Nyaya-Vaiseshika doctrine, had formulated an elaborate theory of inorganic and organic compounds, which equally admitted *iso-bhautic* and *hetero-bhautic* combinations (*cf.* Charaka, Sarirasthana, Chap I, Vimanasthana, Chap. VIII.—also Susruta, Sarirasthana, Chap. I) Like the Vedantists, Charaka holds that each of the gross *bhutas* (*mahabhutas*) is a peculiar ultra-chemical compound of five original subtile *bhutas*. In this sense, every substance is *penta-bhautic*; but for purposes of chemical analysis and synthesis, i e, considered with reference to the *mahabhutas*, all substances in their chemical constitution belong to one or other of the following classes. *mono bhautic*, *bi-bhautic*, *tri-bhautic*, *tetra-bhautic* and *penta-bhautic*. Compounds of different *bhutas*, again, may combine to form more complex substances, and these in their turn unite to give still higher compounds, and so on in progressive transformation, as is more specially the case with organic substances and products.

Physical Character of the Bhutas

The prevailing physical characters of the different *bhutas* and their isomeric modes are enumerated as follows:

Earth-substances :— heavy, rough, hard, inert, dense, opaque, exciting the sense of smell.

Ap-substances :— liquid, viscous, cold, soft, slippery, fluid, exciting the sense of taste.

Tajas-substances :—	hot, penetrative, subtile, light, dry, clear, rarefied, and luminous.
Vayu-substances :—	light, cold, dry, transparent, rarefied, impingent.
Akasa-substances —	imponderable (or light), rarefied, elastic, capable of sound (vibrations).

(*Cf.* Charaka, Sarirasthana, Chap. 26; Susruta, Sutrasthana, Chap 41).

Charaka points out that the primary qualities or specific physical characters of the five *bhutas* are tactile qualities, i e., sensible to touch; e.g., hardness (or roughness) for *kshiti* (earth), liquidity (or yielding to pressure) for *ap*, impelling or moving force (pressure) for *vayu*, heat for *tejas*, and vacuum (non-resistance, penetrability) for *akasa*.

The Mahabhutas—Mechanical Mixtures

Susruta notes that each of the *gross bhutas* (*mahabhutas*) is found mixed up with the other *bhutas*;—e g., the *mahabhuta akasa* is the receptacle (or vehicle) of air, heat-and-light, and water vapour; the *mahabhuta vayu*, of water vapour, light-and-heat, and even fine particles of earth held in suspension, the *mahabhuta tejas*, of earth-particles in the shape of smoke, and also water vapour (Susruta, Sarirasthana, Chap. I).

Mono-bhautic Earth-substances :— Charaka and Susruta regard the following as Earth-substances:

Gold, the five *lohas* (silver, copper, lead, iron and tin) and their rust, arsenic, orpiment, various mineral-earths and salts, sand, precious stones. The salts include common salt, saltpetre, etc Susruta mentions the alkalies, borax, natron, *yavakshara* (carbonate of potash), etc. The *audvidha* salt, an inflorescence of the soil, stands for *reh*

Of these Earth-substances, some were known to be compounds; e g., the chemical salts of the metals, collyrium etc. Susruta describes the preparation of the metallic salts. The

leaves of the metals were pasted over with the salts, and then roasted. These metallic salts are therefore *mono-bhautic* Earth-compounds. Susruta also gives the preparation of mild and caustic alkalies.

According to some, precious stones are rocks (or earths) metamorphosed by natural process in the course of ages.

Ap-substances, Simple and Compound :— Susruta, following Charaka, enumerates various classes of *ap substances* e.g., waters, acids, milks, curds, butters, oils, fats, honeys, molasses, alcoholic liquors, urines, etc. ; in other words, liquids in general.

Pure *ap* (*mahabhuta*) is tasteless, and the six tastes are developed when the *mahabhuta ap* enters into combination, mechanical or chemical, with other *mahabhutas*. Susruta notes that various kinds of *kshiti* are dissolved in the waters of different localities, and where the particles so dissolved consist predominantly of *kishti*, the water tastes acid or salt,— where predominantly watery, the resulting taste is sweet,— where the *kshiti* particles are mixed up with *tejas*, the water tastes pungent or bitter, etc. Such is the case with mechanical mixtures In the case of *bi-bhautic* or *tri bhautic* compounds Charaka mentions that substances with *mahabhuta ap* predominating in their composition taste sweet; with *mahabhutas kshiti* and *tejas* predominating, acid ; with *mahabhutas ap* and *tejas* predominating, salt ; with *mahabhutas vayu* and *tejas* predominating, pungent ; with *mahabhutas vayu* and *akasa* predominating, bitter; and with *mahabhutas vayu* and *kshiti* predominating, astringent (Charaka, Sutrasthana, Chap. 26 ; *cf.* Susruta, Sutrasthana, Chap. 42).

In fact with the exception of Susruta's waters which are mechanical mixtures, or rather solutions, all these *ap-substances* are organic products and, as such, *penta bhautic*, i.e., compounded of all the five *mahabhutas*; and the particular 'taste' which is developed depends on the relative proportion of the *mahabhutas*, and the predominance of one or more of them in the *penta-bhautic* compound in question.

Qualities of Compounds

The isomeric modes of each *mahabhuta* have specific colours, tastes, etc. due to their structure, i.e., the arrangement of their atoms; and the physicochemical characters of compounds, whether of the same or of different *mahabhutas*, result from the collocation in unequal proportion of the different forces latent in the atoms of the component substances. Charaka adds that the varied forms (textures) and colours of organic substances, whether vegetable or animal, are derived in the same way.

Susruta ignores Charaka's distinction between *mahabhuta* and *subtile bhuta*, and views every substance as in reality *penta-bhautic*, and it is only the relative predominance of a particular *bhuta* or *bhutas* in any substance that determines its class (Susruta, Sutrasthana, Chap. 41).

Chemical and Physical Processes

In the writings of the medical schools of ancient India, originating from Charaka and Susruta, we frequently come across instances of chemical composition and decomposition, by processes, more or less crude, of calcination, distillation, sublimation, steaming, fixation, etc Mention may also be made of the various metallurgical processes described, e g, extraction, purification, killing, calcination, incineration, powdering, solution, distillation, precipitation, rinsing or washing, drying, steaming, melting, casting, filling, etc. To these were added several special processes for mercury (e.g., fixation). Application of heat in different measures—strong, medium and mild, was often employed to give rise to the product in view.

Organic Compounds

These were divided into two classes—vegetable and animal The molasses, the fermented liquors, the saps and juices of plants, fruit acids, vegetable ashes and alkalies, together with

the tissues of plants, are vegetable compounds. Honey, milk, curd, butter, fat, bile, urine, and other excreta, together with the organs and tissues of animals, are animal substances. Charaka notices vegetable as well as animal oils. The viscous (oily) substances are classed under four heads—butters, oils, fats, and marrows. Salts may be either mineral or vegetable salt.

Susruta divides poisons into two classes, vegetable and animal; but several poisons, expressly termed mineral poisons, are included in the first class.

All organic substances, whether animal or vegetable, are *penta-bhautic*, being compounded of greater or less proportions of the five *mahabhutas*.

All the component substances of the body are *penta-bhautic* compounds, though sometimes they are assigned to the particular *bhutas* which predominate in their compositions; e.g., bile to *tejas*, lymph, chyle, blood, fat, urine, sweat and other secretions to *ap*, and skin, flesh, bones, nails, hair, etc., to *kshiti* (Charaka, Sarirasthana, Chap. II, IV and VII).

CHEMISTRY OF DIGESTION

The chemistry of digestion has also been elaborately discussed by Charaka and Vagbhata.

The food we eat contains five kinds of *penta-bhautic* organic compounds From their radicles or predominant elements, the substances are named *earth-compounds*, *ap-compounds*, *tejas-compounds*, *vayu-compounds* and *akasa-compounds*. The *earth-compounds* supply the hard formed matter of the body, the *tejas-compounds* give the animal heat (or the metabolic heat), the *vayu-compounds* are the sources of the motor force in the organism, the *ap-compounds* furnish the watery parts of the organic fluids, and the *akasa-compounds* contribute to the finer etheric essence which is the vehicle of the conscious life. Roughly speaking, the *earth-compounds* answer to the nitrogen compounds in the food, the *tajas-compounds*

to the hydrocarbons (heat producing), and the *vayu-compounds* to the carbohydrates (dynamic). The *ap-compounds* are the watery parts of food and drink The flesh, for example, is a tissue composed principally of *earth-compounds*, the fat, of the *earth-* and *ap-compounds*, the bones of *earth-*, *vayu-* and *tejas-compounds*. The *tejas compounds* predominate in the composition of the blood. For purposes of digestion it is stated that different operations of the metabolic heat (perhaps different digestive fluids are also meant) are required to digest the different substances in the food.

Formation of Molecular Qualities in Chemical Compounds

The Charaka school, which, we have seen, was an offshoot of the Samkhya, supplemented the above account of inorganic and organic compounds with a characteristically Samkhya explanation of the formation of molecular qualities by chemical combination. In Charaka's view, the colours, tastes, etc. of the molecules of chemical compounds result from the collocation in unequal proportion and from the unstable equilibrium of the different forces latent in the atoms (*paramanus*) themselves

Chemistry of Colours

The colours of chemical compounds have also been accounted for on the basis of the doctrine of Charaka by his followers. Gangadhara, in the Jalpakalpataru, a commentary on the Charaka Samhita (Calcutta, 1869), furnishes the following explanation.

The qualities of the atom tend to produce similar qualities in the molecule. A molecular quality is, therefore, the result of the conjunction or opposition, as the case may be, of the atomic tendencies. When, for example, the five *bhutas* combine to produce an organic compound (the human body), *tejas*, *ap* and

kshiti (earth) tend to produce red, white and black respectively; but in the body (a compound substance) the yellow colour may happen to be produced as the result of these tendencies in that particular proportion and collocation But the molecule forms a fresh collocation, redistributes the Mass and Energy, and sets up new forces in the system, which, coming into play, modify the potencies (or tendencies) in the component atoms and thus determine the resultant This is elaborated into a curious but complete theory of the colours of chemical compounds.

The colour and other qualities of a simple substance (an isomeric mode of any *bhuta*) are the result of the potencies lodged in that particular collocation of Mass, Energy and Essence Now, when two such substances unite, their colours etc. tend to be produced, but the combination brings on a fresh distribution of Energy, Mass and Essence, and the forces thus set free may powerfully modify or even extinguish the separate tendencies or potencies of the component simple substances For example, when we prepare a collyrium by mixing equal parts of sulphur and mercury (the black sulphide of mercury), we find the resulting compound black. It should be remembered that each of the substances (sulphur and mercury) contains *sattva* (Essence), *rajas* (Energy) and *tamas* (Mass) in different proportions, and that predominant *tamas* (Mass or Inertia) always produces black, predominant *sattva* (Essence), white, and predominant *rajas* (Energy), red. Now, in the black sulphide of mercury, the white of the mercury tends to produce white, and the yellow of the sulphur yellow· and if these tendencies were not obstructed, the result would be a mixed colour. But, in the particular collocation in question, the *tamas* of the mercury becomes intensive, and the black of the now intensive *tamas* extinguishes the white of the uncompounded mercury, which was due to prevailing *sattva*, as well as the yellow of the uncompounded sulphur, which was due to the combined operation of white-producing *sattva* and red-producing *rajas*. Again, when, with proper apparatus and by the application of heat, we combine mercury and sulphur to produce the red sulphide of mercury, the resulting colour is explained by the fact that in

this new collocation the *rajas* (Energy) of the mercury becomes intensive, and, extinguishing both the white-producing *sattva* of the mercury and the yellow-producing *sattva-rajas* of the sulphur, imparts a red colour to the compound. In these cases as also in the formation of red by mixing powdered turmeric with lime, or whenever a new colour is produced in the compound, it is to be explained by the dominance of *tamas, rajas* or *sattva*, or their combinations, and the extinction of the uncompounded tendencies (or potencies) by the forces set free in the new collocation But there are cases where the colour of the compound is a mixed colour resulting from the colours of the combining substances; e.g., when sulphide of mercury and calcined tin are mixed, the resulting colour is evidently a mixed one (*patala*, pink), which is easily explained by the colours of the component substances

Parinama-vada versus Arambha-vada

Charaka's view of the formation of a new quality or a new substance is based on the Samkhya teaching as to the conservation and transformation of Energy, and brings chemical synthesis in a line with evolutionary change (*parinam*). On this view, a new substance may arise by spontaneous or isomeric change, i.e, by the interplay of Energies within the system of any given substance, in the absence of any action from without. New qualities like new substances are only readjustments of the old, and continual changes are going on by spontaneous disintegration and recombination. Opposed to this evolutional view of chemical synthesis is the Nyaya-Vaiseshika doctrine of *arambha-vada*, according to which no change of substance or quality, no effect, in short, can take place except by the action of one component element (substance or quality) on another. A binary molecule, for example, cannot possess any 'specific quality' of a kind not represented in each of the two component atoms In the cosmic process, no atom can exist free and uncombined with another atom, and every specific quality in a substance can be ultimately analysed into the union of two 'specific qualities' *of*

the same class in two ultimate particles, which cannot be further divided. A single colour, smell or taste in a single particle, until it can link itself on to another specific quality *of its own class* in a second particle, cannot characterise any substance formed by the union of these particles as material causes. Hence an *earth-atom* cannot unite with an *ap-atom*, to form a new substance of which both the particles must be equally regarded as material causes. At any rate, such a compound, if effected, would be smell-less, as of the two constituent atoms, only one, viz., the *earth-atom*, possesses smell. A compound of *earth* and *vayu* would be smell-less, colourless and tasteless, and so on. The Nyaya-Vaiseshika does not deny that there may be compounds of different *bhutas*, nor does it deny the causal operation of specific qualities as efficient or energising (dynamic) causes, but it refuses to place these compounds on the same footing as compounds of isomeric modes of the same *bhuta*; and it accepts the 'material' causality, in such cases, of only one of the *bhutas*, regarding the others as 'co-efficients'.

The earlier Samkhyas including the medical schools of ancient India brushed all this aside as a distinction without a difference. The Vedantists, as we shall presently see, flouted this doctrine of *arambha-vada*. The Jainas, in opposing this Vaiseshika view of atomic combination, hit upon a solution of the problem of chemical affinity. Others again, found out a *via media*. They held that a molecule of the structure EA (one atom of *earth* and one atom of *ap*) would exhibit some variety of colour and taste resulting from the joint action of the atoms and of their several colours and tastes. But as in the combination EA only the *earth-atom* possesses smell, and the *ap-atom* is smell-less, and as, moreover, no quality in a compound substance can result except from the joint action of the similar (potential) qualities of at least two component elements, it follows that a molecule of the structure EA would not manifest the energy of smell, potentially contained in the *earth-atom*. Hence, admitting the combination EA for a smell-less compound, the upholders of this view would suppose a molecule of the type E_2A (i.e., two atoms of *earth* and one

of *ap* (to explain any *bi-bhautic* compound of *earth* and *ap* (like the plant saps and fruit juices), which exhibits smell in addition to the peculiarities of colour and taste.

Weights and Measures

Measures of Time and Space

30 *kshanas* = 1 day : 2 *ghatikas* = 1 *kshana* : 30 *kalas* = 1 *ghatika* ; 30 *kashthas* = 1 *kala* : 18 *nimeshas* = 1 *kashtha* : 30 *tatparas* = 1 *nimesha* : and 100 *trutis* = 1 *tatpara*.

This makes a *truti* of time equal to 1/33,750 of a second, which is nearly the measure of the *paramanu* of time as given in Vishnupurana (*vide* Bhaskara's Siddhanta-Siromani circa 1150 A.D.).

The above measures were in use among the astronomers, but the physicists computed according to the following Table, given both in Udayana's Kiranavali and Sridhara's Nyaya-kandali :

30 *muhurtas* = 1 day (24 hours) : 30 *kalas* = 1 *muhurta* : 30 *kashthas* = 1 *kala* : 18 *nimeshas* = 1 *kashtha* : 2 *lavas* = 1 *nimesha* : 2 *kshanas* = 1 *lava*.

This makes 1 *kshana* of the Nyaya-Vaiseshika equal to 2/45 of a second. The Nyaya assumes that the unit of physical change (or the time occupied by any single antecedent step in a causal series before the succeeding step is ushered in) is equal to a *kshana* (2/45 of a second). The astronomers were familiar with far smaller measures of time.

Measures of Weight and Capacity

The Amarakosha mentions measures of three kinds—weight, length, and capacity.

The *krishnala* (*gunja raktika*, the black- and red-berry of the shrub *Abrus precatorius*) was employed as a natural

measure of weight. 80 *krishnala* berries on the average weigh 105 grains Troy, and this must be taken as the basis of our computation, though in current practice 80 *krishnalas* are taken to be equivalent to 210 grains

The conventional measures were, however ;—one gold *masha* was the weight of 5 *krishnalas* of gold, 1 *suvarna* or *tola* weighed as much as 16 *mashas*, and one *pala* as much as 4 *suvarnas* or *tolas*. A *pala* of gold, therefore, weighs 320 *krishnalas* (Manu Chap. VIII).

A *masha* of gold, therefore, would weigh $6\frac{9}{16}$ grains, a *tola*, 105 grains (in current practice it weighs about 180 grains) ; and a *pala*, 420 grains Troy

1 *silver masha* = 2 *krishnalas*, 1 *dharana* = 16 *silver mashas ;* 1 *pala* = 10 *dharanas*. 1 *krishnala* = 1296 *trasarenus*.

A *trasarenu*, as a measure of weight, therefore, is the equivalent of 7/6912 of a grain Troy, or double this according to current measures

But the *trasarenu* of physics is a different conception. It stands for the 'minimum visible', i e., as the physicists define it, that which is 'just discernible' as a glancing particle in the slanting beams of the morning (or afternoon) sun, coming into dark room through a chink or orifice of a window. This is a measure of size.

Measures of Capacity :—Here the standard was furnished by the *kudava*, a vessel described as 3 *angulis* long, 3 *angulis* broad, and $1\frac{1}{2}$ *anguli* deep,—with a cubical capacity of $13\frac{1}{2}$ cubical *angulis* 4 *kudavas* = 1 *prastha*, 4 *prasthas* = 1 *adhaka* 4 *adhakas* = 1 *drona*, and 4 *dronas* = 1 *khari* or *bhara*.

24 *angulis* make 1 *hasta*, cubit, which may be taken to be 18 or 19 inches.

A *kudava* would contain about 4 *palas* of distilled water at 30°C

SIZE OF THE MINIMUM VISIBLE (ATOM)

The supposed thickness of the just discernible mote in the sunbeam, called a *paramanu* in technology and a *trasarenu* in Natural Philosophy, follows directly from Varahamihira's table:—8 *paramanus* make 1 *rajas* (*ratharenu*), 8 *rajas* make 1 *balagra* (filament of hair), 8 *balagras* make 1 *liksha*, 8 *likshas* make 1 *yuka*, 8 *yukas* make 1 *yava*, 8 *yavas* make 1 *anguli*, 24 *angulis* make 1 *hasta* (cubit, 18 inches). The thickness of the *minimum visible* (the finest perceptible mote in the slanting sunbeam) is, therefore, taken to be 3×2^{-20} or 1/349525 of an inch. The volume of a spherical *trasarenu* (or *paramanu* of the *silpasastra* or technology) would, therefore, be $\frac{4}{3}\pi \times 3^3 \times 2^{-60}$ of a cubic inch. It may be here noted that such a *trasarenu* is supposed in the medical schools to contain 30 chemical atoms (*paramanus* of Natural Philosophy) according to one estimate, or 60 according to another. The size of an atom must have been conceived to be less than $\pi \times 3 \times 5^{-1} \times 2^{-62}$ of a cubic inch.

The magnitude of *paramanu* is called *parimandalya* in the Nyaya-Vaiseshika, the name suggesting that the *paramanus* were conceived to be spherical in shape. The Nyaya-Vaiseshika calls a *paramanu* a mere point without any dimensions, but in the Samkhya-Patanjala, a *paramanu*, though indefinitely small, had still dimensions, being divisible into *tanmatras*, which were themselves integrations of *bhutadi*. The diameter of a spherical *paramanu* must have been conceived to be less than 3×2^{-20} of an inch (i.e., less than the conventional *paramanu* with which linear measures begin), and the volume of a *paramanu* would, therefore, in accordance with Bhaskara's formula, be smaller than $\frac{4}{3}\pi \times 3^3 \times 2^{-63}$ or $\pi \times 3^2 \times 2^{-61}$ of a cubic inch. The *tanmatras* were conceived as smaller still

That these were conventional measures arbitrarily assumed goes without question; for, of course, the Hindus had no physical data for a mathematical calculation of these minute quantities.

I shall now proceed to give an account of the chemistry of the schools other than the Samkhya-Patanjala, and the affiliated Yoga and medical schools, discussed above. I shall confine myself here to the theory of the subject in the briefest outline.

The Vedantic View

The Vedantists believe *Maya* to be the 'material cause' of the world. The power of *Maya* is the power to realise the unreal—to impart practical Reality, or mediate existence, to that which does not and cannot possess absolute Reality or self-existence. *Maya* is at once real and unreal, while the *Brahma* (Self) is absolute Reality, absolute Intelligence and absolute Bliss. The world evolves out of *Maya*, so that *Maya* in the Vedanta replaces the *Prakrti* of the Samkhya. But *Maya*, and by implication the world, originate out of *Brahma*, not by a process of evolution, but of *vivarta* (self-alienation). The self-alienation of the Absolute, acting through *Maya*, produces in the beginning *akasa*, one, infinite, ubiquitous, imponderable, inert and all pervasive. The world, thus begun, goes on evolving in increasing complexity. The other *sukshma bhutas*, classes of subtile matter, evolve from *akasa*, in an ascending linear order,—*akasa* giving off *vayu*, *vayu* giving off *tejas*, *tejas* giving off *ap*, and *ap* giving off *kshiti*. *Akasa*, one, infinite, all-pervasive, has the capacity of sound. *Vayu*, subtile gaseous matter, emanates from the universal *akasa*, and is instinct with the potential of mechanical energy (impact, pressure). *Tejas*, subtile radiant matter, emanates from *vayu*, and contains in potentia the energy of light and heat. *Ap*, subtile viscous matter, is the transformation of *tejas*, and is instinct with the energy that stimulates the nerve of taste; and lastly *kshiti* (Earth) subtile hard matter, which is the transformation of *ap*, possesses the latent energy of smell.

But the subtile rudiments of matter must be compounded in various ways, to give rise to the gross consituent matter of the world. These forms of gross matter are called *mahabhutas*.

There are five kinds of *mahabhutas* (gross matter corresponding to the five *sukshma bhutas*—subtile matter), and the process by which a *mahabhuta* is produced from the *sukshma bhutas* is called "panchikarana" (quintuplication). All the five *sukshma bhutas* are present as ingredients, though in different proportions, in each *mahabhuta*

The *mahabhuta earth*, gross earth-matter, is composed of four parts of subtile earth-matter, and one part each of the other forms of subtile matter. The *mahabhuta vayu* is composed of four parts of subtile gaseous matter, and one part each of the other forms of subtile matter. And similarly with the other *mahabhutas*.

Hence if ak, v, t, ap and e represent the five forms of subtile matter (*akasa*, *vayu*, *tejas*, *ap*, and *earth*), and Ak, V, T, Ap, and E stand for the corresponding *mahabhutas*, we may represent the constitution of the *mahabhutas* as follows :—

$Ak = ak_4 . (v_1 . t_1 . ap_1 . e_1)$, ak_4 being the radicle.
$V = v_4 . (ak_1 . t_1 . ap_1 . e_1)$, v_4 being the radicle.
$T = t_4 . (ak_1 . v_1 . ap_1 . e_1)$, t_4 being the radicle.
$Ap = ap_4 . (ak_1 . v_1 \; t_1 \; e_1)$, ap_4 being the radicle.
$E = e_4 . (ak_1 . v_1 . t_1 . ap_1)$, e being the radicle.

In forms of gross or complicated matter, the potential energies (qualities) become actualised. The *mahabhuta akasa* manifests sound; *vayu*, sound and mechanical energy; *tejas*, sound, mechanical energy and heat-light; *ap*, the energy of the taste-stimulus in addition; finally *earth*, the energy of the smell-stimulus added to the foregoing.

Others hold that *akasa*, ether, never enters as a component part, and is always one and indivisible. In this view the four *mahabhutas*—*vayu*, *tejas*, *ap* and *earth* alone are supposed to be compounded, and by a process which may be called quaternion :—

$V = v_3 . (t_1 . ap_1 . e_1)$
$T = t_3 . (v_1 . ap_1 . e_1)$
$Ap = ap_3 . (v_1 . t_1 . e_1)$
$E = e_3 . (v_1 . t_1 . ap_1)$.

These compound forms, as before, are supposed to exercise their specific energies actively. Others again hold that the *mahabhutas*—*tejas, ap* and *earth* alone are compounded by a process named: *trivrit-karana* (triplication). Thus $T = t_2 (ap_1 . e_1)$, $Ap = ap_2 . (t_1 . e_1)$, $E = e_2 . (t_1 . ap_1)$.

The *sukshma bhutas* are forms of homogeneous and continuous matter, without any atomicity of structure; the *mahabhutas* are composite; but even these are regarded as continuous, and without any atomic structure. The Vedanta speaks of *anu* (*paramanu*) not as an ultimate indivisible discrete constituent of matter, but as the smallest conceivable quantum or measure of matter. In the Samkhya doctrine, the atomic structure is ordinarily accepted. The *gunas* are supposed to be bounded and indefinitely small in size (except the *gunas* giving rise to *akasa* and *manas* which are unlimited), and hence the *tanmatras* and *paramanus* must be conceived to have a discrete structure

PARINAMA—EVOLUTIONARY PROCESS

When the *mahabhutas* are once formed, the different kinds of substances are derived from them by the evolutionary process called *parinama* (transformation). Matter is constantly undergoing change of state. The effect is only the cause in a new collocation. Change is of two kinds :—

(1) Change by a spontaneous process, without external influence, including isomeric change The Vedantists believe in spontaneous disintegration and reintegration. Action from without, impressed force *ab extra*, is not always a condition of change of state (whether of rest or of motion);—nor is it necessary that more than one substance should combine to generate another substance or variety of substances (e g., the formation of curds from milk, of ice from water, etc.).

(2) Change due to combination with other substances Such combination may produce (i) a compound substance possessing like qualities with the constituents, or (ii) unlike

compounds with new qualities, "heteropathic effects". Any new quality evolved through (chemical) combination is called *samhata bhuta-dharma*, e.g., the intoxicating power of the fermented rice and molasses, which does not exist in the ingredients taken separately. This *sambhuyakriya* corresponds to chemical combination, and the Vedantists, like the Samkhyas, explain this only as the evolution of the latent energy in a new collocation. But, unlike the mediaeval Samkhya, the Vedanta freely recognises the combination of heterogeneous *bhutas*. Thus, *earth*, *ap*, *tejas* and *vayu* freely combine in different proportions and groupings to produce the variety of substances in the world. For example, the animal organism is a compound of all the five *bhutas*. It is not merely the concomitant or efficient causes that may be heterogeneous to the material cause, as the Naiyayikas contend, but several heterogeneous substances (*bhutas*) may unite as 'material causes' to produce a new substance.

The Vedantists resolve all activities, physical, vital, as well as psychical, into modes of motion, subtile cosmic motion.

The Atomic Theory of the Buddhists

The Vaibhashikas and the Sautrantikas hold that the *vayu-atoms* are touch-sensibles, having impact or pressure for their characteristic property, and by aggregation form the element *vayu*; the *tejas atoms* are colour-and-touch-sensibles, having heat for their characteristic, and by aggregation form the *tejas bhuta*; the *ap atoms* are taste-colour-and-touch-sensibles with a characteristic viscosity, and form the *ap element* by aggregation; and finally the *earth-atoms* are smell-taste-colour-and-touch-sensibles, possessing a characteristic dryness or roughness, and by their aggregation form the *earth-element*. The *bhutas* thus originated combine to form aggregates, which are classed as inorganic substances, organisms and organs.

The Atomic Theory of the Jainas

Of the nine categories of the Jainas, that of Ajiva (the not-Soul or non-Ego) consists of five entities, four of which are immaterial, viz., merit, demerit, space and time, and the fifth material. The last is called *pudgala* (matter), and this alone is the vehicle of Energy, which is essentially kinetic, i.e., of the nature of motion. Everything in the world of not-Soul (the non-Ego) is either an entity, or a change of state in an entity. *Pudgala* (matter) and its changes of state, whether of the nature of subtile motion or of Evolution, must furnish the *physical* as opposed to the *metaphysical* basis of all our explanations of Nature. *Pudgala* (matter) exists in two forms,—*anu* (atom) and *skandha* (aggregate). The Jainas begin with absolutely homogeneous mass of *pudgalas*, which, by differentiation, breaks up into several kinds of atoms qualitatively determined, and by differentiation, integration, and differentiation in the integrated, forms aggregates (*skandhas*). An *anu* has no parts, no beginning, middle or end. An *anu* is not only infinitesimal, but also eternal and ultimate. A *skandha* may vary from a binary aggregate to an infinitum. A binary *skandha* is an aggregate of two *anus* (atoms), a tertiary *skandha* is formed by the addition of an atom (*anu*) to the binary and so on *ad infinitum*. The ascending grades are (i) what can be numbered, (ii) indefinitely large, (iii) infinity of the first order, (iv) infinity of the second order, and so on.

General Properties of Matter

The specific characters of the *pudgalas* (Matter) are of two kinds, (i) those which are found in atoms as well as in aggregates, and (ii) those which are found only in aggregates. Qualities of touch, taste, smell, and colour come under the first head. The original *pudgalas* being homogeneous and indeterminate, all sensible qualities, including the infra-sensible

qualities of atoms, are the result of evolution. Every atom thus evolved possesses an infra-sensible (or potential) taste, smell and colour, (one kind of each) and two infra-sensible tactile qualities, e.g., a certain degree of roughness or smoothness (or dryness or moistness ?) and of heat or cold. *Earth-atoms*, *ap-atoms*, etc are but differentiations of the originally homogeneous *pudgalas* The tactile qualities appear first, but qualities of taste, smell and colour are involved in the possession of tactile qualities An aggregate (*skandha*), whether binary, tertiary, or of a higher order, possesses (in addition to touch, taste, smell and colour) the following physical characters :—(*a*) sound, (*b*) atomic linking, or mutual attraction and repulsion of atoms, (*c*) dimension, small or great, (*d*) figure, (*e*) divisibility, (*f*) opacity and casting of shadows, and (*g*) radiant heat and light.

Sensible qualities. Tactile qualities are of the following kinds —hardness or softness, heaviness or lightness (degrees of pressure), heat or cold, and roughness or smoothness (or dryness and viscosity). Of those, the atoms (*anus*) possess only temperature, and degrees of roughness or smoothness; but all the four kinds of tactile qualities in different degrees and combinations characterise aggregates of matter from the binary molecule upwards The Jainas appear to have thought that gravity was developed in molecules as the result of atomic linking Simple tastes are of five kinds,—bitter, pungent, astringent, saline and the sweet Salt is supposed by some to be resolvable into sweet, while others consider it as a compound taste. Smells are either pleasant or unpleasant The simple colours are five in number—black, blue, red, yellow and white Sounds may be classed as loud or faint, bass (thick) or treble (hollow), clang or articulate speech.

The most remarkable contribution of the Jainas to the atomic theory relates to their analysis of atomic linking, or the mutual attraction (or repulsion) of atoms, in the formation of molecules The question is raised in Umasvati's Jaina *sutras* (circa A.D 40)—what constitutes atomic

linking ? Is mere contact (or juxtaposition) of atoms sufficient to cause linking ? No distinction is here made between the forces that bind together atoms of the same *bhuta*, and the chemical affinity of one *bhuta* to another. The Jainas hold that the different classes of elementary substances (*bhutas*) are all evolved from the same primordial atoms. The intra-atomic forces, which lead to the formation of chemical compounds, do not, therefore, differ in kind from those that explain the original linking of atoms to form molecules.

Mere juxtaposition is insufficient ; linking of atoms or molecules must follow before a compound can be produced. The linking takes place under different conditions. Ordinarily speaking, one particle of matter must be negative, and the other positive ; the two particles must have two peculiar opposite qualities, roughness and smoothness (dryness and viscosity ?), to make the linking possible. But no linking takes place, where the qualities, though opposed, are very defective or feeble. We have seen that, ordinarily speaking, two homogeneous particles, i.e , both positive, or both negative, do not unite. This is the case where the qualities are equal in intensity. But if the strength or intensity of the one is twice as great as that of the other, or exceeds that proportion, then even similar particles may be attracted to each other. In every case, change of state in both the particles is supposed to be the result of this linking, and the physical characters of the aggregate depend on the nature of this linking. When particles of equal intensity (negative and positive) modify each other, there is mutual action ; in cases of unequal intensity the higher intensity transforms the lower, it being apparently thought that an influence proceeds from the higher to the lower. All changes in the qualities of atoms depend on this linking. This appears to be a crude anticipation of the ionic theory of chemical combinations, very crude but immensely suggestive, and possibly based on the observed electrification of smooth and rough surfaces as the result of rubbing. The Tattvarthadhigama of Umasvati, which

expounds the theory, most probably dates back to the first half of the first century A.D.

[This may be compared to the Berzelius's Dualistic Hypothesis of chemical combination.]

The Nyaya-Vaiseshika Chemical Theory

The relation of the specific characters of molecules (and higher aggregates) to the original atomic qualities is reduced in the Nyaya-Vaiseshika to certain canons, as embodied in their theory of atomic combination given below.

Theory of Atomic Combination

The four kinds of atoms are *earth*, *ap*, *tejas*, and *vayu* atoms, possessed of characteristic mass, numerical unit, weight, fluidity (or its opposite), viscosity (or its opposite), velocity (or quantity of impressed motion—*vega*); also characteristic potential colour, taste, smell or touch, not produced by the chemical operation of heat *Akasa* has no atomic structure and is absolutely inert, being posited only as the substratum of sound, which is supposed to travel wave-like in the manifesting medium or vehicle of *vayu* (air). Only the other four *bhutas* unite (or disunite) in atomic or molecular forms. The orthodox view is that the presence of *earth-atoms* is necessary whenever chemical transformation under the operation of heat takesp lace.

Atoms cannot exist in uncombined state in creation They may combine in one or other of the following ways :—

1. One *earth-atom*, by an original tendency, unites with another, to form a binary molecule. In the same way binary molecules of other *bhutas* are formed. The atoms are possessed of an inherent *parispanda* (rotary or vibratory motion), and when they unite in pairs, *so long as there is no chemical operation under the action of heat corpuscles*, the

original qualities of the atoms produce homogenous qualities in the binary molecules.

The question as to the existence of a triad, a tetrad, a pentad, etc. of atoms is one of the moot points of the Nyaya-Vaiseshika. The orthodox view is that the primordial infinitesimal particles (atoms) start with an incessant vibratory motion, and an inherent impulse that drives them to unite in pairs—a sort of 'monovalency', as it were, exhausted with the formation of a binary molecule. The binary molecules now combine by threes, fours, fives, etc. to form larger aggregates as the variety of elementary substances, the particular collocation in any case being not only determined by physical causes, but also serving to satisfy the ends of the moral law in creation.

According to Kanada's view, atoms have an inherent tendency to unite, but some unite in pairs, others in triads, others in tetrads, etc. This may happen in two ways,—either by the atoms falling into groups of threes, fours, etc. direct, or by the successive addition of one atom to each preceding aggregate.

A triad (*tryanuka*), then, holds together three atoms (*anus*), not three binary molecules (*dvyanukas*) as on the orthodox hypothesis. Similarly with tetrads, pentads, etc.

In Prasastapada's view, these binary molecules are grouped by threes, fours, fives, etc. to form different isomeric modifications. The variety of Earth-substances is due to differences in the arrangements of the molecules (e.g., their greater or less density and, above all, their grouping or collocation), which account for the specific characters manifested by these isomeric substances.

According to Udayana (in Kiranavali), these original differences in molecular grouping, leading to distinctions of genera and species, however mechanically or physically explained, come under the operation of moral and metaphysical causes, i e, of ideal ends in the moral government of the Universe, which are superimposed upon the physical order, but which

do not come within the scope of Natural Philosophy. An elementary substance, thus produced by primary atomic combination, may, however, suffer qualitative change under the influence of heat. The process is as follows.—(1) The impact of heat corpuscles decomposes the binary (tertiary or quarternary) molecules into homogeneous atoms possessing only the generic characters of the *bhuta* concerned;—(2) the impacts of heat particles continue, and transform the characters of the atoms, determining them all in the same way;—(3) the heat particles continue to impinge, and reunite the atoms so transformed to form binary (or other) molecules in different orders or arrangements, which account for the specific characters or qualities finally produced. The Vaiseshika holds that there is decomposition into homogeneous atoms, transformation of atomic qualities, and finally recombination, all under the influence of heat. The Nyaya, on the other hand, thinks that the molecules and larger aggregates assume the new characters under the influence of heat without decomposition into homogeneous atoms, or change of atomic characters.

CHEMICAL COMBINATION

Chemical combination takes place either between two or more substances which are isomeric modifications of the same *bhuta*, or between substances which are modes of different *bhutas*.

A. *Mono-Bhautic Compounds*.—The simplest compounds are *mono-bhautic* compounds, i.e., compounds of different substances which are isomeric modes of the same *bhuta*.

(a) *Mono-bhautic compounds of the first order*.—Under the impact or impulse of heat corpuscles, the substances in chemical contact break up into their atoms. These atoms are homogeneous, possessing only the original physical and chemical characters of the *bhuta* concerned. As the specific differences between isomeric substances arise from the arrange-

ment or collocation of the atoms, the substances lose their distinctive marks on decomposition into the latter. Under the continued impact (or, it may be, impulse) of heat particles, these atoms take on new characters. It is heat and heat alone that can cause this transformation of the colours, tastes, smells, etc., in these original *bhuta-atoms.* What particular colours, tastes, smells or physical characters will be produced in the atoms depends on (1) the nature of the constituent substances in contact, (2) the intensity or degree of the heat, and (3) the species of *tejas-corpuscles* that impinge on the atoms, or the nature of the impact.

Now when atoms have all been determined in the same way, they begin to recombine again under the impact (or impulse) of the heat particles, giving rise to binary molecules (or tertiary, etc.); and these then form higher aggregates. It seems to be generally held that at the final step one or more atoms of one constituent substance unite with one or more atoms of the other constituent substance or substances to form a molecule of the compound; but the question is not of much significance for *mono-bhautic* compounds of the first order; as in these cases, the atoms have before this all lost their distinctive characters and become homogeneously transformed. The compound so produced will possess the new characters of the transformed atoms, so far as taste, smell, etc. are concerned; but as the molecular arrangement or structure may vary, different compound substances may result from the same components.

(b) *Mono-bhautic compounds of higher orders*:—Again, *mono-bhutic* compounds of the first order may chemically combine to form higher compounds, and as the ultimate *bhuta* substratum is the same, the process of decomposition and recomposition will be essentially the same as before. The only doubtful point is whether in this case the component compound substances are broken up only into their constituent molecules, or into the original homogeneous *bhuta-atoms.* Some of the later Vaiseshika scholiasts hold that the latter happens in

every case of chemical composition, however complex; but the earlier Vaiseshika conceived that in the case of compounds of compounds, the decomposition does not proceed so far as the original *bhuta atoms*, but that it is the specifically determined atoms, constituting the molecules of the component compounds, that are transformed under the impact of the heat-corpuscles: and then one such transformed atom (one or more according to another version) from the molecule of one component unites with one similarly transformed atom (one or more according to the other version) from the molecule of the other component. In this hypothesis it is assumed that the atoms are similarly transformed, i.e., become endowed with the colour, taste, smell, etc. of the product, the moment before the chemical combination takes place. Similarly, when milk is transformed into curd, one view is that the transformation takes place (under internal heat) in the constituent atoms of the milk molecules, atoms specifically determined as milk, and not in the original atoms of the *bhuta* (or *bhutas*) entering into the composition of milk. In these cases, the atomic contact is called "constituent contact", and all the atoms are equally regarded as material causes of the compound.

B. *Hetero-Bhautic Quasi Compounds*:—The Nyaya-Vaiseshika maintains that in the case of *bi-bhautic* (or *poly-bhautic*) compounds, which are only quasi-compounds, there is another kind of contact between the heterogeneous atoms of the different *bhutas*; this may be called "dynamic contact". In some cases, it so happens that the atoms of different isomeric modes of the same *bhuta* do not chemically combine under the mere application of heat;—they require to be surrounded (and 'excited' or 'energised') by atoms of different *bhutas*. For example, in the case of the oils and fats, as well as of plant saps and fruit juices, the Earth-atoms must be dissolved in water (*ap*), and it is only when the water-atoms (*ap*-atoms) congregate round the former that dynamic intra atomic forces are set up, and the Earth-atoms (with the water atoms in dynamic contact) now take on peculiar infra-sensible characters (colours, tastes,

smells) under the impact of the heat-corpuscles, and then, under further impact, fall into groupings or collocations (of a very peculiar nature to be presently explained) which determine the nature of the composite substance thus produced. Here it is the water-atoms that are dynamic, and excite the Earth atoms, and these substances, oils and fats, as well as acids, are, because of the Earth-radicles, regarded as Earth-compounds (or Earth-substances). In the above instances, *ap* (water) acts as dynamic, but *tejas* and *vayu* can also act in the same way on Earth-particles. Conversely, Earth-particles may act dynamically on the atoms of the other *bhutas*. For example, in the case of mercury and the metals which are conceived in the Nyaya-Vaiseshika to be igneous bodies (in fact they are supposed to be formed under the subterranean heat), the *tejas* corpuscles are believed to form the radicles, and the Earth-particles are dynamic.

It was also believed that even gold can be evaporated and made to disappear by the application of intense heat. But while every *bhuta* can act dynamically as exciter or energiser, it is the *earth bhuta* alone which is capable of exercising the power of arrest or inhibition of molecular motion, or the motion of particles due to gravity as in fluids, or the power of counteracting the tendency in a given set of atoms to fall into a peculiar order or group.

Oils, Fats, Milks—Bi-bhautic quasi-compounds, with ap as energiser :—Oleaginous substances are divided by Udayana into (1) oils, derived from vegetables, (2) butters, derived from milk, and (3) fats, derived from animals. The medical schools, as we have seen, recognise animal oils as distinguished from vegetable oils. Vegetable fats are also mentioned. Vachaspati in the Tatparyyatika contends that mustard oil has not the flavour and smell characteristic of the true oils (sesamum, linseed, etc.), and is classed with the latter by convention. Judged by the flavour test, *amiksha* (the casein substance fromed by mixing milk-curd with hot boiled milk) is to be classed with milk-substances. So also *takra*, whey,—but *vajina*, the thin fluid that is left after

the *amiksha* (casein substance) is separated, cannot be classed as milk. It may be added that the milks and curds, as well as oils and fats derived from different species of vegetables or animals, are supposed to differ in their ultimate structural arrangement and therefore in kind; but Vallabha thinks that the *ghees* (clarified butters), prepared from different kinds of milk, are of the same kind; in other words, the milks and curds are 'polymeric', the *ghees* (clarified butters), 'isomeric', using these terms as before in a loose general sense. Vallabha notes that *ghees* do not differ in kind, as milks and curds do.

Mixtures like Soups, Solutions, etc.

A soup is a physical mixture of a peculiar kind, from which evaporation ordinarily sets the water free. When meat is boiled in water, there is the application of heat, with chemical changes in the meat; but the combination of meat-particles and water-particles in the soup is only a physical combination, and not a chemical one. It is, of course, not a true compound, neither is it a quasi-compound like milk (in which the water-particles are energisers of the Earth-particles). Milk, for example, retains its milky substance, when it coagulates or becomes solid (this of course is also the case with *mono-bhautic* substances, whether elementary or compound, e.g., water, which becomes ice); but the substance we call a soup or solution ceases to be a soup or solution, the moment it solidifies. Uddyotakara notices gruel, baths, and lyes (alkaline solutions) as mixtures of this class.

Chemical Action and Heat

The operation of heat is, of course, universally implied in chemical combinations Where the application of external heat is wanting, Vatsyayana, the great Doctor of the Nyaya, points to the operation of internal heat. In the case of combustion, we have seen, Vijnana-bhikshu explains the heat as latent in the Earth-substance, the fuel, from which it

breaks forth. Udayana points out that the solar heat is the source of all the stores of heat required for chemical change in the world. The change of colours in grasses, for example, is due to *tejas*, in the form of latent (invisible) heat, not in the form of *agni* (fire); and the cold in winter cannot take away this store derived from the sun (Udayana,—Kiranavali). Similarly, it is under this solar heat that the unripe mango ripens, i.e, changes colour, taste, smell, etc, showing that there is chemical transformation, or subtile decomposition and recomposition, going on; and this is also the case with the rusting of the metals, which is a combustion due to the solar heat, even as the conversion of food into chyle and of chyle into blood are instances of chemical action due to the internal animal heat. But the kind of contact with heat-corpuscles, in other words, the kind of chemical action which transforms colours, is supposed to differ from that which transforms flavour, and this last from that which produces a change of smell, or tactile quality (Nyayabodhini on Annam Bhatta's Tarkasamgraha). Heat and light rays are supposed to consist of indefinitely small particles, which dart forth or radiate in all directions rectilinearly with a sort of conical dispersion and with inconceivable velocity. They may either (1) penetrate through inter-atomic (or inter-molecular) spaces as in cases of conduction of heat, which when applied under the pot boils the water, or fries the paddy where there is no chemical action in the pot, no decomposition and recomposition of its atoms, no change in the molecular collocation; or, as with light rays in cases of translucency or transparency penetrate through the inter-atomic spaces with *parispanda* of the nature of deflection or refraction in the same way as when fluids penetrate through porous bodies; or, (2) these rays or particles may impinge on the atoms and rebound back—which explains reflection, or otherwise be obstructed by the atoms in their path, which would explain degrees of opacity, the casting of shadows, etc., all these operations being also physical, and unattended with decomposition and recomposition or alteration of molecular grouping; or lastly, (3) these rays may strike

the atoms in a peculiar way, so as to break up their grouping, may transform the physicochemical characters of the atoms, and may again recombine them, all by means of continual impact with inconceivable velocity, an operation which explains all cases of chemical combination.

Arrangement of Atoms in Space

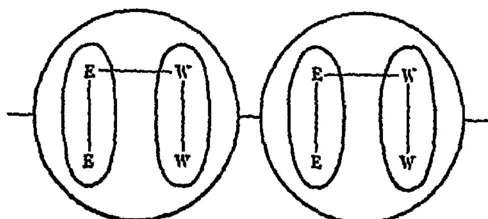
The Nyaya conceives atomic magnitudes as *parimandalya*, a term indicating a spherical shape. To conceive position in Space, Vachaspati takes three axes, one proceeding from the point of sunrise in the horizon to that of sunset on any particular day (roughly speaking from the East to the West); a second bisecting this line at right angles on the horizontal plane (roughly speaking from the North to the South); and the third proceeding from the point of their section up to the meridian position of the sun on that day (roughly speaking, up and down). The position of any point in Space, relatively to another point, may now be given by measuring distances along these three directions, i.e., by arranging in a numerical series the intervening points of contact, the less magnitude or distance being that which comes earlier in this series, and the greater that which comes later. The position of any single atom in space with reference to another may be indicated in this way with reference to the three axes. But this gives only a geometrical analysis of the conception of three-dimensioned Space, though it must be admitted in all fairness that by dint of clear thinking it anticipates in a rudimentary manner not only the foundation of solid (co-ordinate) geometry, but also of the geometry of position, and especially the conception of Space as a manifold, which alone can serve as the basis of a generalisation comprehending all different kinds of geometry, Euclidean and non-Euclidean.

The original physical arrangement of atoms is also given. Each atom is in contact with six other atoms, which gives a cubical arrangement. (Vachaspati, Tatparyyatika, Chap. IV.

Ahnika 2, Sutra 25). This is the typical primordial arrangement; and variations in the collocation of atoms and molecules, as we have seen, were conceived to account for the variety of isomeric modes of the same *bhuta*, as well as of *mono-bhautic* and *poly-bhautic* compounds.

The molecular arrangement in the case of the *bi-bhautic* compounds is very peculiar. Two substances, say Earth and *ap* (water), form a quasi-compound first: and each substance breaks up into atoms, when one atom of Earth comes into contact with one of *ap*. But the two do not form a binary molecule. Instead, this contact of heterogeneous atoms leads to a curious result. The atom of Earth combines with a neighbouring atom of its own class, and forms a binary molecule. Simultaneously the atom of *ap* combines with another *ap*-atom, and forms a binary molecule. Now the first binary molecule links on to the atom of *ap*, and similarly the second binary molecule links on to the atom of Earth. The moment after, the two binary molecules take on the physicochemical character of Earth and *ap* respectively, and simultaneously with the assumption of these physicochemical characters, the binary molecules enter into complex contact. In all this process, work is done only in the first instant, in the contact of an atom of Earth with one of *ap*; the resulting contacts, of atom with binary molecule and of the binary molecules with each other, involve no further expenditure of Energy. Thus we get a particle holding two binary molecules (of Earth and *ap* respectively) in complex contact, and such particles continue to be formed. In this way the particles of the two substances arrange themselves, and the peculiarity of this molecular arrangement explains the resulting mixed or compound qualities of this class of quasi-compounds.

The whole process may be graphically represented as follows :—



Molecules of a *bi-bhautic* quasi-compound ,—graphic formula of complex contact

E = an atom of Earth, W = an atom of Water (*ap*)

E | E = a binary molecule of Earth, W | W = a binary molecule of Water (*ap*)

Molecular and Atomic Motion—Parispanda

Parispanda sometimes stands for atomic and molecular motion, but more often for the subtile motion of atoms or molecules. The radical meaning of the term is whirling or rotary motion, a circling motion, but it may also include simple harmonic motion (e.g., vibration). All action, operation or work, is ultimately traced to this form of subtile motion lodged in the atoms or in the matter-stuff. The Vedanta, for example, speaks of a cosmic vibratory motion. *Akasa* in the Vedanta, as we have seen, is the first stadium in the evolution of matter, which gives off *vayu*, which gives off *tejas*, and so on ; but *akasa* (Ether) itself passes through two stages before the emanation of the *sukshma-bhuta vayu* .— (1) the motionless ubiquitous primordial matter-stuff (*bhutadi* in Samkhya) called *puranam kham*, and (2) a subtile integration, the pure unquintuplicated *sukshma-bhuta* called *vayuram kham* (*tanmatra* stage in Samkhya). It is this subtile *akasa*, in its *tanmatric* integration, i.e., in the derivative form, which is subject to an incessant *parispanda*. The gaseous stage of matter (the Vedantic *vayu*) is indeed matter in a state of

parispandic motion. The Samkhya also conceives this *parispanda* to characterise every process and phenomenon of cosmic evolution *Bhutas*, organisms, mental organs, as modes of *Prakriti*, are all subject to this *parispanda* On the other hand, *Prakriti* as the *avyakta*, the a-cosmic, the unmanifest ground, with resolution only of like to like, is devoid of all *parispandic* motion. The Nyaya-Vaiseshika finds *parispanda* in all forms of matter, except *akasa* which, in that system, is non-atomic and incapable of any change or activity. But all atoms, from those of *vayu* downwards, are in incessant motion. The world at bottom is an infiinitude of continually whirling (or vibratory) particles. All physical action consists in motion. The Nyaya-Vaiseshika rejects force, power, operation, except as modes of motion. But, though all action of matter on matter is thus resolved into motion, conscious activity is sharply distinguished from all forms of motion In this Nyaya-Vaiseshika differs from Samkhya-Vedanta, which, as we have seen, considered everything other than Intelligence, the *Purusha* or the transcendental Self, to arise in the course of cosmic Evolution, and therefore, to be subject to *parispandic* motion.

The wave-motion and current-motion or convection have been termed *gati-santana* (*gati* means velocity, *santana* denotes serial motion ; motion which progresses forwards). Mere vibration has been described as *kampa-santana* or *spandana*. Charaka notes three kinds of *santanas*, serial motions, viz., those of water, sound and light. Chakrapani points out that a wave of sound travels more rapidly than a wave of water, and much less rapidly than a ray of light. The last named implies the rectilinear propagation of indefinitely minute corpuscles, in all directions, with inconceivable velocity, and a sort of conical dispersion (*cf.* Uddyotakara—Vachaspati). A wave of water implies the transmission of vibratory motion in the water particles A wave of sound is conceived by some on the analogy of a wave of water ; only the air waves, or the sound waves in and through the vehicle of air waves, travel by concentric circles, not in one but in all planes (this assumes transverse waves). Others hold that the air waves. or the sound and air

waves, are propagated by the transmission of the vibration in all directions, leading to conjunction and disjunction of air particles, so that the waves may be said to expand by alternate concentric spherical layers of rarefaction and condensation (this assumes longitudinal waves). The Vakya-padiya describes articulate sounds (*varnas*), and indeed all sounds (*sabdas*), as only forms of air set in motion, with rarefaction and condensation, and capable of variations of velocity and configuration (Vakya-padiya, Kanda I, Sloka 109).

The Weight of Air

Udayana argues that air must be a distinct and independent *bhuta* ; for if air were made of the *earth-bhuta*, it would have weight, and it has none. To prove the absence of weight, he refers to an experiment.

A small bladder made of thin membrane, filled with air, will not cause a greater descent in the scale of a balance than the same bladder weighed empty. Hence, the air possesses no weight Then Udayana makes an interesting statement. It may be objected, he says. by one who accepts the weight of air—that this argument is inconclusive. For, a counter-experiment may be suggested. The balloon filled with smoke (or gas—*dhum*) rises in the air, whereas the air-filled balloon comes down. This would go to show that air has weight Udayana replies that this would only show that both smoke and air have no weight. The Hindus appear to have been ignorant of the principle of Archimedes, at least as applied to gases Vallabhacharya in the Lilavati speaks of a peculiar resistance to sinking exercised by water, which explains the tendency in certain objects to float or to come up to the surface of the water : but the description shows that he had no clear ideas on the subject (*cf*. Udayana, Kiranavali—*vayu-nirupanam*).

For a fuller reference to the subjects dealt with in this section see "Positive Sciences of the Ancient Hindus" by the same author.

ASIA	AEGEAN, GREECE, AND WESTERN EUROPE
——→	
Kish, Ur in-bronze	
	EARLY MINOAN. *Knosses*: Copper, gold, silver, bronze, lead Purple dye, glaze *Mycenæ* Glass.
imitation	THE HITTITES Useful iron (c 1400 B.C), steel weapons Tin oxide glaze, cobalt glass IRON AGE (c 1200 B.C.)
	CLASSICAL GREECE **Thales** (c.624-545 B C.) —Water, primal matter. **Anaximander** (c 611-546 B.C.) — 'Apeiron', primal matter. **Anaximenes** (c. 550 B C) —Air, primal matter. **Heraclitus** (c. 536-470 B.C.) —Fire, primal matter. **Pythagoras** (c. 570-490 B.C.) —Geometrical conception of matter.
e a che- s writings ry direc- apparatus l symbo- etal and Prepared	**Empedocles** (c. 490-430 B.C.) —Four element theory. **Anaxagoras** (c. 500-427 B.C.) postulated an external intelligence. **Leucippus** (c. 500 B.C.), and **Democritus** (c. 460-370 B.C) proposed an atomic theory. All matter consists of eternal, moving, indestructible atoms, qualitatively alike but differing in size, shape and mass. **Aristotle** (384-322 B.C) postulated the primary matter, called '*hule*' **Theophrastos** (315 B.C.) described the manufacture of white lead.
	WESTERN EUROPE

SANSKRIT TEXTS

Extracts from

VRINDA

वृन्दलिखितसिद्धयोगादुद्धृतानि वचनानि—

रसेन्द्रेण समायुक्तो रसो धत्तूरपत्रजः ।
ताम्बूलपत्रजो वाथ लेपनं यौकनाशनम् ॥ VI, 13.

त्रिफलाव्योषसिन्धूत्थयष्टीतुत्थरसाञ्जनम् ।
प्रपौण्डरीकं जन्तुघ्नं लोध्रं ताम्रं चतुर्दश ॥
द्रव्याण्येतानि संचूर्ण्य वर्त्तिः कार्या नभोऽम्बुना ।
नागार्ज्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ॥

LX, 148-149.

सर्व्वेषां लोहजातानां कान्तं भवति कान्तिदम् ।
* * पाचयेल्लोहमादौ सप्तदिने ततः ॥
धात्रीपिप्पारकोद्भूतस्वरसेनार्करश्मिषु ।
स्थापयेत् * * * ॥
काकमाचीरसे पश्चात् * * ।
पुनर्भ्राम्ते सर्व्वत्र खलितव्यं प्रयत्नतः ॥
पश्चाच्चूर्णं विधातव्यमप्रमत्तेन धीमता ।
इति सूर्य्यमुखेनैव मारणं परिकीर्तितम् ॥
* * * * लोहमारणम् ।
रसगन्धकताम्राणां चूर्णं कृत्वा समांशिकम् ।
पुटपाकविधौ पक्वा मधुनालोड्य संलिहेत् ॥

Abbreviations used · M. Ms = Madras Manuscript.
K. Ms = Kásmir Manuscript.
R. R S. = Rasaratnasamuchchaya
Rr by Nag. = Rasaratnákara by Nágárjuna

सितं सुवर्णं बहुधर्मभावितं
करोति साक्षाद्दरकुङ्कुमप्रभम् ॥ 4.

दरदशुद्धिः ।

कुलत्थकोद्रवक्काथे नरमूत्रेण पाचयेत् ।
वेतसाद्यम्लवर्गेण दत्त्वा क्षारं पुटत्रयम् ॥ 5

किमत्र चित्रं कदलीरसेन
सुपाचितं सूरणकन्दसंस्थम् ।
वातारितैलेन घृतेन ताप्यं
पुटेन दग्धं वरशुद्धिमेति ॥ 6.

माक्षिकशोधनम् ।

द्विगुणा विमला पथ्या रम्भातोयेन संयुता ।
लवणैर्वर्कदुग्धेन ताम्रपत्राणि लेपयेत् ॥ 9.
अग्नौ सन्तप्य निर्गुण्डीरससिक्तानि सप्तधा ।
मासान् वसुरसेनैव शुल्वशुद्धिर्भविष्यति ॥ 10

पत्रतः सर्व्वलोहशोधनम् ।

अम्लवेतसधान्याम्लमेषीतोयेन शुध्यति ॥ 11.

विमलशुद्धिः ।

चपलाद्या धातवः सर्व्वे जम्बीररसभाविताः ।
शोधितास्त्रिदिनं पञ्चमृत्तिकाभस्मलावणैः ।
संयुताः संशोधयन्ति पुटपाकेन काञ्चनम् ॥ 12

हेमशोधनम् ।

नागेन क्षारराजेन ध्मापितं शुद्धिमृच्छति[2] ।
तारं त्रिवारनिक्षिप्तं पिशाचीतैलमध्यगम् ॥ 13.

तारशुद्धिः ।

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(1) The text reads वक्क, which is incorrect.

(2) This verse also occurs in Rasárnava

अहो नु चित्रं पृथिवीभवेन
क्षारेण मेषीपयसा घृतेन ।
तैलेन शुद्धं द्रुतषोडशांशं
भवेच्च शुल्वं शशिशृङ्गसन्निभम् ॥ 14

मोक्षमारोटपालाश-क्षारगोमूत्रभावितम् ।
वज्रकन्दशिखाकल्क-फलमूलसमन्वितम् ॥ 23.
तत्कल्कं काष्ठकं साक्षाच्चूर्णं वैक्रान्तसम्भवम् ।
सारघेन[1] समायुक्तं मेषशृङ्गीद्रवान्वितम् ॥ 24.
पिण्डितं मूकमूषास्थं धामितञ्च हठाग्निना ।
तत्रैव पतति सत्त्वं वैक्रान्तस्य न संशयः ॥ 25
वैक्रान्तसत्त्वम् ।

क्षौद्रं गन्धर्व्वतैलं सघृतमभिनवं
गो रसं मूत्रकञ्च
भूयो वातारितैलं कदलिरसयुतं
भावितं कान्तितसम् ।
मूषां कृत्वाग्निवर्णामकणकरनिभां
प्रक्षिपेच्चाक्षिकेन्द्रं
सत्त्वं नागेन्द्रतुल्यं पतति च सहसा
सूर्यवैश्वानराभम्[2] ॥ 25

महावृक्षार्कक्षीराभ्यां स्नोस्नन्येन सुभावितम् ।
मूषायामग्निवर्णायां द्रवेत्ताप्यं न संशयः ॥ 26
कङ्कुष्ठटङ्कणाभ्याञ्च ताप्यं स्नोस्नन्यमर्द्दितम् ।
पश्चात्सत्त्वं निपतति सत्यं मूषा तु अग्निवत् ॥ 27
काञ्जिकं बहुशस्स्विन्नं ताप्यचूर्णं कटुत्रिकम् ।
कृत्वाम्बुमधुभ्यां पक्वं वज्रपायसभावितम् ॥ 28.

(1) These couplets also occur in R R S, with this difference that in the latter नवसार has been substituted for सारघ

(2) Cf Rasārnava Vide Sans. Texts, VII 12—13

टङ्कणं घृतं क्षौद्रं संयुतं पुनरेव च।
धामितं मूकमूषायां शम्भुसत्त्वनिभं भवेत् ॥ 29
कदलीरसशतभावितं घृतमध्वेरण्डतैलपरिपक्वम्।
ताप्यं मुञ्चति सत्त्वं रसकश्चैव त्रिसङ्घाते ॥ 30.

माक्षिकसत्त्वपातनविधिः।

क्षारस्नेहैश्च धान्याम्ले रसकं भावितं बहु।
ऊर्णा लाक्षा तथा पथ्या भूलता धूमसंयुतम् ॥ 31
मूकमूषागतं ध्मातं टङ्कणेन समन्वितम्।
सत्त्वं कुटिलसङ्काशं पतते नात्र संशयः[1] ॥ 32.

रसकसत्त्वम्।

विमलं शिग्रुतोयेन काञ्चीकासीसटङ्कणैः।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥ 35.
माक्षीकक्षारसंयुक्तं धामितं मूकमूषके।
सत्त्वं चन्द्रार्कसङ्काशं पतते नात्र संशयः[2] ॥ 36.

विमलसत्त्वम्।

दरदं पातनायन्त्रे पातितश्च जलाशये।
सत्त्वं सूतकसङ्काशं जायते नात्र संशयः ॥ 37.

दरदसत्त्वम्।

गन्धकश्च प्रभावेण सत्त्वभूयं स्वभावतः।
ततः ख्यातं महासत्त्वं रसेन्द्रस्य समं ततः ॥ 38.

अभ्रकादिसत्त्वपातनविधिः।

* * * * *

एक एव महाद्रावी पार्वतीनाथसम्भवः।
किं पुनस्त्रिभिः संयुक्तो वेतसाम्लाम्लकाञ्जिकैः ॥ 50.

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(1) Cf. Rasárnava, Benares MS V. 37—38

(2) Cf Sans. Texts, R. R S Bk. 11, 103—104.

मुष्काफलानि सप्ताहं वेतसाम्लेन भावयेत्।
पुटपाके ततश्चूर्णे द्रवति सलिलं यथा।
कुरुते योगराजोयं रत्नानां द्रावणं परम् ॥ 51

अभ्रकादिद्रुतपातनविधिः।

तालेन वङ्गं दरदेन तीक्ष्णं
नागेन हेमं शिलया च नागम्।
गन्धाश्मना चैव निहन्ति शुल्वं
तारञ्च माक्षीकरसेन हन्यात् ॥ 52.

* * * *

शुल्वम् अजाक्षीरसुगन्धकेन
तारं स्नुहीक्षीरसुमाक्षिकेण।
यद्यस्य धातोर्विहितञ्च युक्तं
निरुत्थघातं कथितञ्च तीक्ष्णैः ॥ 54
मृतानि लोहानि रसीभवन्ति
रसेन युक्त्यामयनाशनानि।
अभ्यासयुक्त्या पलितादिनाशं
कुर्व्वन्ति तेषाञ्च जराविनाशम् ॥ 55.

इति नागार्जुनविरचिते रसरत्नाकरे वज्रमारण-
सत्त्वपातन-अभ्रकादिद्रुतिद्रावण-वज्रलोह-
मारणाधिकारो नाम द्वितीयः।

अथातो रसबन्धाधिकारं व्याख्यास्यामः।
जम्बीरजैन नवसारघनाम्लवर्गैः
क्षाराणि पञ्च लवणानि कटुत्रयञ्च।
शिग्रूदकं सुरभिसूरणकन्द एभिस्-
संमर्दितो रसन्तृपश्चरतीष्टलोहान् ॥ 1.

चारणजारणविधिः।

* * * *

प्रज्ञापारमिता निशीथसमये स्वप्ने प्रसादीकृतं
नाम्ना तीक्ष्णमुखं रसेन्द्रममलं नागार्जुनप्रोदितम् ॥ 4

* * * *

रसं हेमसमं मर्दंय पीठिकागिरिगन्धकम् ।
द्विपदीरजनीरथ्यां मर्दयेत् टङ्कणान्विताम् ॥ 30
नष्टपिष्टञ्च शुष्कञ्च अन्धमूष्यां निधापयेत् ।
तुषाग्निपुटं दत्त्वा यावद्भस्मत्वमागतः ॥ 31
भक्षणात्साधकेन्द्रस्तु दिव्यदेहमवाप्नुयात् ॥ 32

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गर्भयन्त्रं प्रवक्ष्यामि पीठिकाभस्मकारकम् ।
चतुरंगुलदीर्घेण विस्तारेण च त्र्यङ्गुलाम् ॥ 62
मूषां तु मृण्मयीं कृत्वा सुदृढ़ां वर्त्तूलां बुधः ।
विंशभागन्तु लोणस्य भागमेकं तु गुग्गुलोः ॥ 63
सुश्लक्ष्णं पेषयित्वा तु तोयं दत्त्वा पुनः पुनः ।
मूषालेपं दृढ़ं बद्ध्वा लोणार्द्धंमृत्तिका बुधः ॥ 64
कर्षं तुषाग्निना भूमौ मृदुस्वेदेन स्वेदयेत्[1] ॥ 65
सूतकस्य पलं गृह्य तुर्यांशं सात्तुकं विषम् ।
तत्समं गन्धकं शुल्वं चूर्णं कृत्वा विनिक्षिपेत् ॥ 84.
कृत्वा कज्जलिकामादौ पलं दत्त्वा च गन्धकम् ।
घृतपक्वञ्च तच्चूर्णं पचेदायसभाजने ॥ 85
यावद्द्रवत्वमायाति तत्क्षणात् तं विनिक्षिपेत् ।
पुटे वा कदलीपत्रे सिद्धं पर्पटिकारसम् ॥ 86.

द्वितीयपर्पटीरसः ।

प्रणिपत्य सर्व्वबुद्धान्
(सद्बोधान्) सकलदोषनिर्मुक्तान् ।

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(1) Cf Rasárnava Vide Sans Texts, p 322.

वक्ष्ये सर्व्वहितार्थं
कच्छपुटं सर्व्वसिद्धिकरम् ॥
श्रीशैलपर्व्वतस्थायी सिद्धो नागार्जुनो महान् ।
सर्व्वसत्वोपकारी च सर्व्वभाग्यसमन्वितः ॥
प्रार्थितो ददते शीघ्रं यश्च पश्यति यादृशम् ।
दृष्टा त्यागञ्च भोगञ्च सूतकस्य प्रसादतः ।
सर्व्वसत्वामयविधौ खरसेन तथैव च ॥
तेषां मध्ये प्रधानश्च रत्नघोषः प्रचारकः ।
कृताञ्जलिपुटो भूत्वा नागार्जुनपुरः स्थितः ।
पृच्छते रसकर्म्माणि विद्यादानं ददस्व मे ॥

श्रीनागार्जुन उवाच—

साधु साधु महाप्राज्ञ तुष्टोऽहं भक्तवत्सलः ।
कथयामि न सन्देहस्त्वया परिपृच्छ्यताम् ॥
वलीपलितनाशञ्च तथा कालस्य ध्वंसनम् ।
यथा लोहे तथा देहे क्रमते नात्र संशयः ॥
* * * *
सत्वानां भोजनार्थाय साधिता वटयक्षिणी ।
द्वादशानि च वर्षाणि महाक्लेशः कृतो मया ॥
तत्कालदृष्टद्रव्याणां दिव्या वाणी मया श्रुता ।
अदृष्टप्रार्थिता पश्चाद्दृष्टा त्वं भव साम्प्रतम् ॥

श्रीवटयक्षिण्युवाच—

साधु साधु महासिद्ध * * *
किंचित्प्रार्थय मे सिद्ध तत्सर्व्वं प्रददाम्यहम् ॥

श्रीनागार्जुन उवाच—

यदि तुष्टासि मे देवि सर्व्वदा भक्तिवत्सले ।
दुर्लभं त्रिषु लोकेषु रसवन्धं ददस्व मे ॥

शालिवाहन उवाच—

सुवर्णरत्नभाण्डारं कुमारी मदसुन्दरी।
निवेदितो मयात्मा मे आदेशो देवि दीयताम्॥
साधु साधु महाप्राज्ञ ममादेशप्रपालक।
साधयामि न सन्देहो युष्मत्सत्येन साधकम्॥
पुनरन्यं प्रवक्ष्यामि माण्डव्येन यथा कृतम्।
रसोपरसयोगेन सिद्धं सूतं सुसाधितम्॥
विद्धशुल्वायनं नागं यथार्थकाञ्चनं कृतम्।
* * * * ॥
शास्त्रं वशिष्ठमाण्डव्यं गुरुपार्श्वे यथा श्रुतम्।
तदहं सम्प्रवक्ष्यामि साधनञ्च यथाविधि॥
सहायशोभनाः प्राज्ञा निरालम्भा दृढव्रताः।
कुलीनाः पापहीनाश्च साधयन्ति जितेन्द्रियाः॥
कोष्ठिका वक्रनालञ्च गोमयं सारमिन्धनम्।
धमनं लोहपत्राणि औषधं काञ्जिकं विड़म्॥
कन्दराणि विचित्राणि * * *
सर्व्वमेलयनं कृत्वा ततः कर्म्म समारभेत्॥

रत्नघोष उवाच—

साधयित्वा प्रयत्नेन कोटिवेधी महारसः।
शरीरेण विनैतेन सर्व्वं भवति निष्फलम्॥

नागार्जुन उवाच—

कथयामि न सन्देहः साक्षाण्डेन यथा कृतम्॥
आर्द्रत्वञ्च घनत्वञ्च चापल्यं गुरुतेजसः।
यस्यैतानि न दृश्यन्ते तं विद्याद्रससूतकम्॥
नानावर्णं भवेत्सूतं विहाय घनचापलम्।
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि॥
गुरुत्वमरुणत्वं वा तेजो भास्करसन्निभम्।

अग्निमध्ये यदा तिष्ठेत् खोटबन्धस्य लक्षणम्[1] ॥

अथातो रसेन्द्रमङ्गलानि यन्त्रविधिः ।

शिलायन्त्रं, पाषाणयन्त्रं, भूधरयन्त्रं, वंशयन्त्रं, नलिकायन्त्रं, गजदन्तयन्त्रं, दोलायन्त्रं, अधःपातनयन्त्रं, भुवःपातनयन्त्रं, पातनयन्त्रं, नियामकयन्त्रं, गमन(?)यन्त्रं, तुलायन्त्रं, कच्छपयन्त्रं, चाकीयन्त्रं, वालुकायन्त्रं, अग्निसोमयन्त्रं, गन्धकलाहिकायन्त्रं, मूषायन्त्रं, हण्डिकायन्त्रं, कम(?)भाजनयन्त्रं, घोणायन्त्रं, गुडाभ्रकयन्त्रं, नारायणयन्त्रं, जालिकायन्त्रं, चारणयन्त्रम् ।

अथ प्रवक्ष्ये सुगुरूपदेशात्
यः पाटलाख्यस्य रसस्य बन्धः ।
यस्य प्रभावात् क्षयमेहकच्छ-
ज्वरादिकुष्ठामयनिग्रहः स्यात् ॥
निक्षिप्य खल्ले त्रिपुरान्तकस्य
बीजं विशुद्धार्द्धपलप्रमाणम् ।
क्वाथेन तस्य त्रिपुरोद्भवेन
सम्मर्दयेत्तु त्रिदिनानि यावत् ॥
कन्यारसेन त्रिदिनं ततश्च
सप्तार्चिषा चाथ दिनत्रयञ्च ।
चूर्णैस्त्रिकाया रजनीरजैन[2]
सम्मर्दितं तम् उषतोयधौतम् ॥
त्रीणि प्रमाणान्यथ सप्तमञ्च
सम्पातयेत् पातनयन्त्रयोगात् ।

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(1) Cf Rasarnava. Vide Sans Texts, XII. 197—98.

(2) The text seems to be incorrect.

सम्पातितो निर्म्मलतामुपैति
सर्व्वप्रयोज्योपि हितं प्रशस्तम् ॥
पलं समादाय रसस्य तस्य
शुल्वस्य शुद्धस्य च कर्षमेकम् ।
कृत्वाष्टपिष्टौ विधिवर्त्तयोश्च
गन्धाश्मचूर्णं द्विगुणञ्च देयम् ॥
घृतप्रयोगेण विपाच्य पश्चान्-
निक्षिप्य खल्ले परिमर्दितञ्च ।
निष्कञ्च मात्रां लम्रतस्य दत्त्वा
गुञ्जाप्रमाणा गुटिका च कार्य्या ॥
श्रीलोकनाथस्य विभोः प्रसादात्
ज्ञातं मया पोटलिकाविधानम् ॥
* * * * *

इति रसेन्द्रमङ्गलं समाप्तम् ।

Extracts from

RASARNAVA

रसार्णवादुद्धृताः श्लोकाः ।

श्रीभैरव उवाच—

रसोपरसलोहानि वसनं काञ्जिकं विड्म् ।
धमनी लोहयन्त्राणि खल्लपाषाणमर्दकम् ॥
कोष्ठिका वङ्कनालश्च गोमयं सारमिन्धनम् ।[1]
मृन्मयानि च यन्त्राणि मुसलोलूखलानि च ॥
संडसीयन्त्रसंदंशं मृत्पात्राय:करोटकम् ।[2]
प्रतिमानानि च तुला छेदनानि कषोत्पलम्[3] ॥
वंशनाली लोहनाली मूषामार्गास्तथौषधी ।
स्नेहाम्ललवणक्षारविषाण्युपविषाणि च ॥
एवं संगृह्य सम्भारं कर्मयोगं समाचरेत् ॥
द्रवद्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च[4] ।
मुखे तिर्यक्कृते भाण्डे रसं सूत्रेण लम्बितम् ।
तं स्वेदयेत्तत्र गतं दोलायन्त्रमिति स्मृतम् ॥
लोहमूषाद्वयङ्कृत्वा द्वादशाङ्गुलमानतः ।
ईषच्छिद्रां छिद्रमिता[5]मेकां गन्धकसंयुताम् ॥

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(1) Cf कोष्टिका वङ्कनालं च गोमयं सारमिन्धनम् ।
Rr by Nág Ch IV

(2) M Ms reads सण्डपीपट्टसन्दंशा मृत्पात्र येकमीरकम् ।

(3) M Ms has कषोत्पलम् ।

(4) K. Ms reads भाण्डंच पूरितार्द्धरसेन च । The reading adopted in the text is that of the M Ms, which quite agrees with R. R S (see p 73, Poona ed).

(5) M Ms reads ईषच्छिद्रान्वितामेकाम् ।

मूषायां रसयुक्तायामन्यस्यां तां प्रवेशयेत् ।
तोयं स्यात्सूतकस्याध ऊर्द्ध्वाधो वह्निदीपनम् ॥
रसोनकरसं भद्रे यत्नतो वस्त्रगालितम् ।
दापयेत्प्रचुरं यत्नादाप्लाव्य रसगन्धकौ ॥
स्थालिकायां निधायोर्द्ध्वं स्थालीमन्यां दृढ़ां कुरु ।
सन्धिं विलेपयेद्यत्नान्मृदा वस्त्रेण चैव हि[1] ॥
स्थाल्यन्तरे कपोताख्यं पुटं कर्षाग्निना सदा ।
यन्त्रस्याधः करीषाग्निं दद्यात्तीव्राग्निमेव च ॥
एवन्तु त्रिदिनं कुर्य्यात्तप्ततोये विमर्दयेत् ।
न तत्र चीयते सूतो न च गच्छति कुत्रचित् ॥
ऊर्द्ध्वं वह्निरधश्चापो मध्ये तु रससङ्ग्रहः ।
मूषायन्त्रमिदं देवि जारयेद्[2] गन्धकादिकम्[3] ॥
गर्भयन्त्रं प्रवक्ष्यामि पिष्टिकाभस्मकारकम् ।
चतुरङ्गुलदीर्घा[4] च मूषिकां मृन्मयीं दृढ़ाम् ॥
अङ्गुलमध्यविस्तारं वर्तुलं कारयेन्मुखम् ।
लोहस्य[5] विंशतिर्भागा एकभागस्तु गुग्गुलोः ॥

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(1) Rr by Nág reads मध्ये तु रसस्थिति ।

(2) M Ms. has सारयेत ।

(3) गगनादिकम् in R S S (p 74 Poona ed) Couplets लौहसूषाद्वयं गच्छति कुत्रचित् have been borrowed by R. R S in the Book on apparatus

(4) Rr by Nág. reads—

चतुरङ्गुलदैर्घ्येण विस्तारेण च त्र्यङ्गुलम् ।
मूषात्तु मृन्मयी कुर्यात् सुदृढा वर्तुला बुध ॥
विंशभागानि लोणस्य भागमेकन्तु गुग्गुलो. ।
सुश्लक्ष्णं पेषयित्वा तु तोयं दत्त्वा पुनः पुनः ॥
मूषालेपं दृढं बद्ध्वा लौहपार्श्वस्थिका बुधः ।
कुर्य्यात्तुषाग्निं मूषी च मृदुस्वेदेन स्वेदयेत् ॥

(5) K Ms reads लोणस्य ।

सुश्लक्ष्णं पेषयित्वा तु तोयं दद्यात् पुनः पुनः ।
मूषालेपं ततः कुर्यात्तिलपिष्टञ्च निक्षिपेत् [1] ॥
कुर्य्यात्तुषाग्निं भूमौ च [2] मृदुस्वेदन्तु कारयेत् ।
अहोरात्रं त्रिरात्रं वा रसेन्द्रो भस्मतां व्रजेत् ॥
जारणे सारणे चैव रसराजस्य रञ्जने ।
यन्त्रमेव परं कर्म्म यन्त्रविद्या महाबला ॥ [3]
औषधिरहितश्चायं हठाद्यन्त्रेण बध्यते ।
तस्माद्यन्त्रबलं चैकं न विलंघ्यं विजानता ॥ 3-24.
खर्परं सिकताकारं कृत्वा तस्योपरि न्यसेत् ।
अपरं खर्परं तत्र शनैर्मृद्वग्निना पचेत् ॥
पञ्चक्षारैस्तथा मूत्रैर्लवणैश्च विडैस्ततः ।
हंसपाकः स विज्ञातो [4] यन्त्रतत्त्वार्थकोविदैः ॥
कृष्णा रक्ता च पीता च शुक्लवर्णा [5] च मृत्तिका ॥
आद्या श्रेष्ठा कनिष्ठा च मध्यमा मध्यमा मता ॥
दग्धधान्यतुषोपेता मृत्तिका कोष्ठकारिका [6] ।
वक्रनालक्षते वापि शस्यते सुरसुन्दरि ॥
गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ।
अजाश्वानां मलं दग्धं दग्धा मृत्कृष्णतां गता ॥
वासकस्य च पत्राणि वल्मीकस्य मृदा सह ।
पेषयेदग्नितोयेन अनेन वज्रतां गतम् ॥

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(1) K. Ms. has तिलपिष्टं सुनिक्षिपेत् ।

(2) M. Ms reads तुषकर्षाग्निना भूमौ ।

(3) M Ms has यन्त्रौषधं परं कर्म यन्त्रौषध्या महारसम् ।

(4) M. Ms reads हंसपादस्तु विख्यातः ।

(5) M Ms. has शुक्लकृष्णा ।

(6) M Ms reads कोष्ठकाविधौ ।

मद्द्येत्तेन बध्नीयाद्दृक्ङ्कनालञ्च कौठकम् ।
शोण दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ॥
चिरमङ्गारकः किट्टं वज्रेणापि न भिद्यते ।
दग्धाङ्गारस्य षड्भागा भागैका कृष्णमृत्तिका ॥
चिरमङ्गारकः किट्टं वज्रमूषा प्रकीर्त्तिता ॥
तुषदग्धसमा दग्धमृत्तिका चतुरंशिका ।
श्वेतपाषाणसंयुक्ता [1] वज्रमूषा प्रकीर्तिता ॥
प्रकाशा चान्धमूषा च प्रकृतिर्द्विविधा स्मृता ।
प्रकाशमूषा देवेशि शरावाकारसंयुता ॥
द्रव्यनिर्वाहणे सा च वैदिकैः सुप्रशस्यते [2] ॥
अन्धमूषा तु कर्तव्या गोस्तनाकारसन्निभा ।
पिधानकसमायुक्ता किञ्चिदुत्तानमस्तका ॥
पक्वलेपे तथा भागे [3] वन्हिमेलापके तथा ।
सैवाच्छिद्रान्विता मध्ये गम्भीरा मारणोचिता ॥
मोचचारस्य [4] भागौ द्वौ इष्टकांशसमन्वितौ ।
मृद्भागास्तारशुद्ध्यर्थमुत्तमा वरवर्णिनि ॥ 29-46
आवर्त्तमाने कनके पीता तारे सिता शुभा ॥
शुल्वे [5] नीलनिभा तीक्ष्णे कृष्णवर्णा सुरेश्वरि ॥
वङ्गे ज्वाला कपोता च नागे मलिनधूमता ॥
शैल्ले तु धूमरा देवि आयसे कपिलप्रभा ॥

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(1) M. Ms. has कृष्णपाषाणसंयुक्त ।

(2) M. Ms reads सा चार्वैदिकैस्तु प्रशस्यते ।

(3) M. Ms has वङ्गे ।

(4) M. Ms. reads मोचचारस्य ।

(5) K. Ms. has शुल्के, which seems to be incorrect

अयस्कान्ते धूम्रवर्णा सस्यके लोहिता भवेत् ।
वज्रे नानाविधा ज्वाला सस्यके[1] पाण्डुरप्रभा ॥
न विस्फुलिङ्गा नच बुद्बुदाश्च
यदा न रेखापटलं न शब्दः ।
मूषागतं रत्नसमं स्थिरञ्च
तदा विशुद्धं प्रवदन्ति लोहम् ॥
षोडशाङ्गुलविस्तीर्णं हस्तमात्रायतं शुभम् ।
धातुसत्त्वनिपातार्थं कोष्ठकं वरवर्णिनि ॥ 49-57.

इति श्रीपार्वतीपरमेश्वरसंवादे रसार्णवे रससंहितायां यन्त्रमूषाग्निवर्णनो नाम चतुर्थः पटलः ।

त्रिक्षाराष्टङ्कणक्षारो यवक्षारश्च सर्जिका ।
तिलापामार्गकदलीपलाशशिग्रुमोचकाः ।
मूलार्द्रकचिञ्चाश्वत्था वृक्षक्षाराः प्रकीर्तिताः ॥ V, 35-36.
माक्षिकं विमलं शैलं[2] चपलो रसकस्तथा ।
सस्यको दरदश्चैव स्रोतोऽञ्जनमथाष्टकम्[3] ।
अष्टौ महारसाः * * * VII, 2-3.
क्षौद्रगन्धर्वतैलाभ्यां गोमूत्रेण घृतेन च ।
कदलीकन्दसारेण भावितं माक्षिकं मुहुः ।
मूषायां मुञ्चति ध्मातं सत्वं शुल्वनिभं मृदु ॥ 12-13.
विमलं शिग्रुतोयेन काक्षीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥

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(1) M. Ms reads खसत्वे ।

(2) K Ms has शिला ।

(3) K Ms reads शीताञ्जनकथाष्टकम्, which is incorrect.

मौक्तिकाक्षारसंयुक्तं धापितं मूकमूषया ।
सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥ [1] 20-21.
गौरः श्वेतोऽरुणः कृष्णश्चपलस्तु प्रशस्यते ।
हेमाभश्चैव ताराभो विशेषाद्रसबन्धकः ॥
शेषौ मध्यौ च लाक्षावच्छीघ्रद्रावी तु निष्फलौ ।
वङ्गवद्द्रवते वह्नौ चपलस्तेन कीर्तितः ॥ 26-27
मृत्तिकागुडपाषाणभेदेतो [2] रसकस्त्रिधा ॥ VII, 31.

किमत्र चित्रं रसको रसेन,
भावितः ।
क्रमेण भूत्वा तुरगेण रञ्जितः
करोति शुल्वं [3] त्रिपुटेन काञ्चनम् [4] ॥ VII, 34.

ऊर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।
मूकमूषागतो ध्मातष्टङ्कणेन समन्वितः ॥
सत्त्वं कुटिलसङ्काशं मुञ्चत्यत्र न संशयः [5] ॥ VII, 37-38.
सस्यकं
शशशोणितमध्ये वा दिनमेकं निधापयेत् ।
तस्य चूर्णं महेशानि पादसौभाग्यसंयुतम् [6] ॥

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(1) विमलं शिग्रुतोयेन काङ्क्षीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥
मौक्तिकाक्षारसंयुक्तं धमितं मूकमूषगम् ।
सत्त्वं चन्द्रार्कसङ्काशं पतति नात्र संशयः ॥
Rr by Nag II 35, 36.

(2) M Ms has भेदक ।

(3) M. Ms reads गन्धम् ।

(4) This sloka is exactly the same as it is in Rr by Nág I 3

(5) ऊर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।
मूकमूषागतो ध्मातष्टङ्कणेन समन्वितः ॥
सत्त्वं कुटिलसङ्काशं पतति नात्र संशयः ॥
Rr by Nág II 31-32

(6) M Ms reads पादसाम्राज्यसंयुतम् ।

करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ।
मध्यस्थमन्धमूषायां ध्मापयेल्लोकिलात्रयम् ॥
इन्द्रगोपकसङ्काशं सत्त्वं पतति शोभनम् ॥ VII, 41-44.
गोपित्तेन शतं वारान् सौराष्ट्रीं भावयेत्ततः ।
धमित्वा पातयेत्सत्त्वं क्रामणञ्चातिगुह्यकम् ॥ VII, 72-73.
* * * शृणु लोहान्यतः परम् ।
सुवर्णं रजतं ताम्रं तीक्ष्णवङ्गभुजङ्गमाः ।
लोहकं षड्विधं तच्च यथापूर्वं तदक्षयम् ॥ VII, 89-90.
रसजं[1] क्षेत्रजञ्चैव लोहसङ्करजं तथा ।
त्रिविधं जायते हेम चतुर्थं नोपलभ्यते ॥
लोहानां मारणं वक्ष्ये समाहितमनाः शृणु ।
* * * *
नास्ति तल्लोहमातङ्गो यन्न गन्धककेशरी ।
निहन्याद्गन्धमात्रेण यद्वा माक्षिककेशरी ॥ VII, 138-142.

इति श्रीपार्वतीपरमेश्वरसंवादे रसार्णवे रससंहितायां महारसोपरसरत्नलोहलक्षणसंस्कारनिर्णयो नाम सप्तमः पटलः ।

श्रीभैरव उवाच—
कासीसं सैन्धवं माक्षी सौवीरं व्योषगन्धकम् ।
सौवर्च्चलं व्योषका च मालतीरससम्भवः ॥[2]
शिग्रुमूलरसैः सिक्तो विडोऽयं सर्वजारणः ॥[3] IX, 2-3.
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(1) M. Ms has रजकं, which is doubtful

(2) M. Ms has सर्जिका and मालतीमीरसम्भवम् ।

(3) Cf. Rasakalpa II. 51-65. Here व्योषगन्धकौ, सर्जिका and रससंयुतैः seem to be correct

गन्धतालकसिन्धूत्थचूलिकाटङ्कणं तथा।
चारैर्मूत्रैश्च विपचेदयं ज्वालामुखो विड़ः[1] ॥

*   *   *

एवं संगृह्य सम्भारं रसकर्म्म समाचरेत्।
तन्ममाचक्ष्व देवेशि किमन्यच्छ्रोतुमिच्छसि ॥ IX, 9-20.

इति श्रीपार्वतीपरमेश्वरसंवादे रससंहितायां विड़कथनो नाम नवमः पटलः।

काकमाची जया ब्राह्मी मार्जारी रक्तचित्रकः।
मण्डूका मुद्गपर्णी च शृङ्गवेरं सश्राङ्कुरम् ॥
देवदाली शङ्खपुष्पी काकजङ्घा शतावरी।
कुमारी भृङ्गराजश्च निर्गुण्डी ग्रीष्मसुन्दरः।
शूलिनी सूक्ष्मपर्णी च गोजिह्वा चोरकञ्चुकः ॥ X, 52-54
तद्रसैः सर्वदा[2] पाल्यः सप्तधा निर्म्मलो भवेत्।
यामेन[3] पिष्टिकां कृत्वा पातयेदूर्द्ध पातने।
वङ्गनागौ परित्यज्य शुद्धो भवति सूतकः ॥ X, 55-56.
कासीसतुवरीसिन्धुटङ्कणक्षारसंयुतः।
पूर्वभेषजयोगेन सूतकश्चरति क्षणात् ॥ XI, 24.
सौवर्च्चलञ्च कासीसं सामुद्रं सैन्धवं तथा।
आसुरी टङ्कणं चैव नवसारस्तथैव च ॥
कर्पूरञ्चैव माक्षीकं समभागानि कारयेत् ॥
स्नुह्यर्कदुग्धैर्देवेशि मूषालेपं तु कारयेत् ॥
विड़चूर्णं ततो दत्त्वा कनकं जारयेत्प्रिये ॥ XI, 83 86.
नानावर्णं भवेत्सूतं विहाय घनचापलम्।
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥

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(1) K Ms reads अथ ज्वालामुखो विड़ः, Which is grammatically incorrect.

(2) M Ms. has मर्द्दितम।

(3) M. Ms. reads तापेण।

आर्द्रत्वं चपलत्वं[1] च तेजो गौरवचापलम् ।
यस्यैतानि न दृश्यन्ते विद्यात्तं मृतसूतकम् ॥[2]

XI, 197-198.

तीक्ष्णं नागं तथा शुल्वं रसकेन तु रञ्जयेत् ।
समस्तं जायते हेम कुष्माण्डकुसुमप्रभम् ॥ XII, 50.
पञ्चभूतात्मकः सूतस्तिष्ठत्येव सदाशिवः ॥ XII, 78.
भस्मसूतं पलैकञ्च पलमेकञ्च[3] गन्धकम् ।
पुटेन जायते भस्म सिन्दूरारुणसन्निभम् ॥ XIV, 81.
मयूरग्रीवतुल्यञ्च कुङ्कुमं रसकं तथा ।
बालवत्सपुरीषञ्च विषं हालाहलं तथा ॥
रक्तचित्रकचूर्णन्तु समभागानि कारयेत् ।
मर्द्दयेन्मध्यमाम्लेन छायाशुष्काञ्च कारयेत् ॥
मधुना सह संयोज्य नागपत्राणि लेपयेत् ।
मूकमूषागतं ध्मातं नागं रञ्जयति क्षणात् ॥
अशोकपत्ररसेन सप्तवारं निषेचयेत् ।
अष्टाविंशतिकृत्वो वै तैले भूनागसम्भवे ॥
तन्नागं जायते दिव्यं देवाभरणभूषणम् ॥

XVII, 70-74.

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(1) M Ms reads घनत्वम्, which is preferable.

(2) Cf आर्द्रत्वञ्च घनत्वञ्च चापल्यं गुरुतेजसः ।
यस्यैतानि न दृश्यन्ते तं विद्यान्मृतसूतकम् ॥
नानावर्णं भवेत्सूतं विहाय घनचापलम् ।
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥

Rr. by Nág IV.

(3) M. Ms. has * * * पलैकं पन्नगस्य च ।
तावपात्रेण तं कृत्वा मर्द्दयेल्लोहमुष्टिना ।
खदिराग्निना ततः पाच्यं यावन्नागेन मेलनम

Extracts from

RASAHRIDAYA.

भगवद्गोविन्दपादविरचितात्

रसहृदयादुद्धृताः श्लोकाः ।

A = MS from Nepal.

B = MS from India Office Library, with a commentary, named "Bálávabodhiká"

C = MS. from Benares

द्वितीयपटलादुद्धृताः श्लोकाः ।

[टीका—मूर्च्छितरसस्य उत्थापनसंस्कारमाह—]

अमुना विरेचनेन हि सुविशुद्धो नागवङ्गपरिमुक्तः ।

सूतः[1] पातनयन्त्रे समुत्थितः[2] काञ्जिके क्वाथात्[3] ॥

[टीका—अथ मूर्च्छितरसस्य पञ्चमोद्दिष्टपातनसंस्कारं स्पष्टयन्नाह—]

कृत्वा तु शुल्वपिष्टीं[4] निपात्यते नागवङ्गशङ्कातः[5] ।

तस्मिन् दोषान् मुक्त्वा[6] निपतति शुद्धस्तथा सूतः[7] ॥

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(1) A reads पात्य, which makes the sentence incomplete and the metre defective.

(2) A reads शुविशुद्ध, which is a tautology as well as a grammatical error

(3) काञ्जिकेन क्वाथात् is the variant in B. This is a defective metre

(4) A reads सुल्वपिष्टिम् ।

(5) निपात्यैते नागवङ्ग सदोष is the reading in A, which is incorrect as well as defective metre

(6) A reads सुक्त दोषास्त्यक्त्वा ।

(7) A reads शुद्ध, which is a tautology as well as a grammatical error.

अष्टाङ्गुलविस्तारं[1] दैर्घ्येण[2] दशाङ्गुलं लघोभाण्डम् ।
कण्ठादधः समुच्छ्रितचतुरङ्गुलकज्जलाधारम्[3] ॥
अन्तःप्रविष्टतलभाण्ड[4]वदनजलमग्ननिजमुखप्रान्ता[5] ।
उपरिष्टाच्चिपिटपटी[6] दैर्घ्योदरषोडशाङ्गुलविशाला ॥
तस्मिन्नधोर्ध्वभाण्डे[7] निपातितः सकलदोषनिर्मुक्तः[8] ।
सुतरां भवति रसेन्द्रो जीर्णग्रासोऽपि पात्योऽसौ[9] ॥
कृत्वाथ[10] नष्टपिष्टिं त्रिफलाशिखिशिग्रुराजिकापटुभिः ।
संलेप्य चोर्ध्वभाण्डं दीप्तैरुपलैरधः पात्यः[11] ॥
अथवा दीपकयन्त्रे[12] निपातितः सकलदोषनिर्मुक्तः ॥
कच्छपयन्त्रान्तर्गत[13]मृन्मयपीठस्थदीपिकासंस्थः ।
यस्मिन्निपतति सूतः प्रोक्तं[14] तद्दीपिकायन्त्रम् ॥

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(1) B reads अष्टाङ्गुलञ्च विस्तीर्णं, which destroys the metre

(2) B reads दैर्घ्येण तु, wherein तु is redundant

(3) B reads समं तच्चतुरङ्गुलं कृतजलधारा, which mars the metre,

(4) A reads अन्तःप्रविष्टतद्भाण्डं, which is a defective metre,

(5) B reads प्रान्त , which is grammatically incorreet

(6) A has उपविष्टाच्चिपुटपुटिस, which Is senseless

(7) A reads तस्मिन् धूर्ध्वभाण्डे, which is incorrect.

(8) निपातितसकलनिर्मुक्तः, an incomplete variant in A

(9) A has an incorrect reading—ग्रासजीर्णपपात्यासौ ।

(10) This verse and the next two are not found in B

(11) A reads रुपरैरधप्राप्ता, which has no sense

(12) A has दीपनर्यन्त्रे ।

(13) A reads कच्छपर्यन्त्रे अन्तर्गत, which is grammatically incorrect

(14) The word सत् is not found in A, thus making the metre defective.

सप्तमः पटलः ।

[टीका—अथ विड्विधानमारभ्यते—]

ग्रासं न मुञ्चति न वाञ्छति तच्च भूयः
कांश्चिद्गुणान्[1] भजति[2] नित्यमनुक्तमात्रात्[3] ।
यज्जीर्यते प्रचुरकेवलवह्नियोगात्
तस्माद्विड़ैर्मुनिविड़ैः सह[4] जारणा स्यात् ॥

[टीका—विड्विधानमाह—]

सौवर्च्चलकटुकत्रयकाङ्क्षी[5]काशीसगन्धकैश्च विड़ैः ।
शिग्रो रसशतभाव्यैस्ताम्रदलान्यपि हि जारयति[6] ॥

[टीका—विडान्तरमाह—]

सर्व्वाङ्गदग्धमूलकप्रतिगलितं सुरभिमूत्रेण[7] ।
शतभाव्यं बलिवसया[8] तत्क्षणतो जार्य्यते हेम ॥

[टीका—अथ क्षारवृक्षगुल्मौषधीराह—]

कदलीपलाशतिल[9]निचुलकनकसुरदालिवासुकैरण्डाः ।
वर्षाभूवृषमोचक[10]सहिताः क्षारा यथालाभम् ॥

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(1) A reads काचीद्गुणान्, which is incorrect.

(2) B reads व्रजति ।

(3) मुक्तविमुक्तमात्रात्, is the variant in A.

(4) A reads मुनियतैरिसु, which seems to be incorrect मुनिविड़ैः means by seven विड्s, mentioned below

(5) A reads काक्षि, which is incorrect

(6) A has शिग्रुरसशतभावितम् । मस्य दनान्यपि हि जारयति, which is incorrect as well as defective in metre

(7) सर्व्वाङ्ग' दग्धमूलकं रसप्रतिप्रतिगलितसुरभिमूत्रेण, a variant in A, which has no metre at all

(8) A reads शतभावितरसवसया, which has no sense.

(9) तिल is not found in B

(10) A reads माचीक, which seems to be incorrect,

[टीका—क्षारविधानमाह—]

आनीय क्षारवृक्षान् कुसुमफलशिफा-
त्वक्पलाशैरुपेतान्[1]
कृत्वातः खण्डशस्तान्[2] विपुलतरशिला-
पिष्टपात्रातिशुष्कान्[3]।
दग्धं काण्डैस्तिलानां करिसुरभिहया-
जोभिरास्राव्य वस्त्रैः[4]
भस्म त्यक्त्वा जलं तत्[5] मृदुशिखिनि पचेत्
हंसपाकेन भूयः[6]॥

[टीका—क्षारजलपाकलक्षणमाह—]

तत्क्वथ्यमानं हि सबाष्पबुद्बुदान्
यदा विधत्ते[7] क्षणभङ्गुरान् बहून्।
तदा क्षिपेत् त्र्यूषण[8]हिङ्गुगन्धकं
क्षारत्रयं सल्लवणानि भूखगम्[9]॥
द्रव्याणि संमिश्र्य निवृत्य भूतले
व्यवस्थितान्यस्त्रिकटोरिकापुटे[10]।

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(1) कुसुमपलशवापलकष्टैरुपेतान् is an incorrect text in A

(2) A reads कृत्वा ततखंडसहान्, which is incorrect

(3) A has विपुलतरशिलापृष्टगानातिशुष्कान्।

(4) A reads करिसुरभिहयोष्ट्राजकाना च मूत्रे।

(5) A reads तं, which is incorrect

(6) A reads यावत्।

(7) A reads erroneously यथा वहते।

(8) A reads क्षिपेत्त्र्यूखण B reads क्षिपेत्सूषण. Both the readings are incorrect.

(9) A has क्षारवितय पटुलवणं भूमिखग, which mars the metre.

(10) A reads व्यवस्थितान् सस्त्रिकठारिकामुखे। B reads व्यवस्थितशस्त्रकठोरिकापुटे।

संस्थापयेत् सप्तदिनानि धान्यगं
ततः प्रयोज्यं रसजारणादिकम् ॥
[टीका—जारणायां क्षारविधानमाह—]
जम्बीरबीजपूरक[1]चाङ्गेरीवेतसाम्लसंयोगात् ।
क्षारा भवन्ति नितरां गर्भद्रुतिजारणे शस्ताः[2] ॥
[टीका—रसे विड्योजनमाह—]
विड्मधरोत्तरमादौ दत्त्वा सूतस्य चाष्टमांशेन[3] ।
कुर्य्याज्जारणमेवं क्रमक्रमाद्वर्द्धयेदग्निम्[4] ॥

अष्टमः पटलः

[टीका—अथ रसरागोऽभिधास्यते—
अभ्रकजीर्णस्य छायाविशेषमाह—]
जीर्णाभ्रको[5] रसेन्द्रो
दर्शयति[6] घनानुकम्पिनीं छायाम्[7] ।
कृष्णां रक्तां पीतां
सितां[8] तथा सङ्करं मिश्राम्[9] ॥

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(1) A reads बीजपूरक, which is incorrect The word बीजपूर is not found in B

(2) गर्भद्रुतिजारणा सस्ता is an incorrect variant in A

(3) A has दत्ता सूतं चाष्टमासेन, which is not correct as it destroys the metre as well as sense

(4) A reads वर्द्धयेदग्नि, which is grammatically incorrect

(5) A reads जीर्णाभ्रक, which mars the metre.

(6) A reads दृश्यति, which is incorrect.

(7) घनानुकम्पिनी छाया is the variant in A घनानुकम्पर्णछाया is the variant in B Both the reading seem to be incorrect

(8) कृष्णं रक्तं पीतं सितं is the reading in A, which is incorrect

(9) A reads तदा संकरोर्म्मिश्राः, which is incorrect.

[टीका—अभ्रकयोगाद्वर्णविशेषमाह—]

कृष्णाभ्रकेण बलवत्[1] सितरागैर्युज्यते[2] रसेन्द्रस्तु ।
श्वेतैः रक्तैः पीतैः वङ्गैः खलु वर्णतो ज्ञेयः[3] ॥

[टीका—अथ रञ्जितरसप्रशंसामाह—]

अथ निजमेव हि वर्णं[4]
न जहाति यदा स रज्यते[5] रागैः
क्रमशो हि भक्ष्यमाणो[6]
निर्निक्तो[7] रञ्जनं कुरुते ॥

[टीका—अभ्रसत्त्वादीनां योगे रसे व्यवस्थामाह—]

बलमास्तेऽभ्रकसत्त्वे जारणरागाः प्रतिष्ठितास्तीक्ष्णे[8] ।
बन्धश्च सारलोहे[9] सारणमथ[10] नागवङ्गाभ्याम्[11] ॥

[टीका—सर्व्वकरणं तीक्ष्णमाह—]

क्रामति तीक्ष्णेन रसः तीक्ष्णेन[12] जीर्य्यते क्षणाद्ग्रासः[13] ।

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(1) यंतासकेन बलवान् is the variant in A, which is incorrect

(2) A reads शितरागैः पूर्य्यते ।

(3) A has नविप्रतो ज्ञेयं, which has no clear sense. B has वङ्गिवर्णतो ज्ञेयः, which mars the metre

(4) B reads अथ निजकर्म्मवर्णं, which is not correct

(5) A reads यथा रसजीर्य्यते, which is grammatically incorrect

(6) A reads भक्ष्यमाणा, which is incorrect. B reads क्रमशो वचमाणो, which is also incorrect

(7) A reads नारक्तो ।

(8) A reads erroneously प्रतिष्ठिता तीक्ष्णा ।

(9) A reads सारणलोहे., which is incorrect

(10) A reads क्रामणमथ ।

(11) B reads नागवङ्गमतः ।

(12) A reads तीक्ष्णे च ।

(13) A reads यासे, which is incorrect

हेम्नो योनिस्तीक्ष्णं[1] रागान् गृह्णाति तीक्ष्णेन ॥

[टीका—तीक्ष्णहिङ्गुलयोगेन गुणाधिक्यमाह—]

तदपि च दरदेन हतं हत्वा माक्षीकेण रविसहितम्[2] ।
वासितमपि वासनया घनवच्चार्थ्यञ्च जार्थ्यञ्च ॥

[टीका—तीक्ष्णवद्वेतानाह—]

कान्तं वा तीक्ष्णं वा काङ्क्षीं वा वज्रसस्यकं वापि[3] ।
एकतमं सर्व्वं वा रसरजने सङ्करोऽभीष्टः[4] ॥

[टीका—स्वे स्वे विकारे वक्ष्यमाणमाह—]

कुटिले[5] वलमप्यधिकं रागस्तीक्ष्णे तु पन्नगे स्नेहः[6] ।
रागस्नेहवलानि तु कमले शंसन्ति धातुविदः[7] ॥
सर्व्वैरेभिर्लोहैर्माक्षिकमहितैर्मृतिस्तथा गर्भे ।
विड्योगेन तु जीर्णां रसराजो विशति लोहेषु ॥[8]

[टीका—रसवन्धाना मारणे विधानमाह—]

तालक[9]दरदशिलाभिः सं हृच्चाराम्ललवणसहिताभिः ।
समकद्विगुणत्रिगुणान् पुटो वङ्गहङ्गशस्त्राटीन्[10] ॥

[टीका—पुटितधातुकृत्यमाह—]

रक्तस्नेहनिषेकैः सेकं[11] कुर्य्याद्रसस्य पिष्टिरियम्[12] ।

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(1) A reads ज्योतिस्तीक्ष्णं, which has a defective metre

(2) B has omitted हत्वा माक्षीकेण रवि ।

(3) कार्श्वीं वा वज्रशस्यकाटीना, a variant in B

(4) रसेपि हि रसायने विद्यात्, variant in A

(5) This is not found in B

(6) A reads erroneously पन्नगस्नेह ।

(7) A reads धातुविध, which is incorrect.

(8) This sloka is not found in B

(9) A reads तारक ।

(10) निवाङ्कवेङ्ग शस्त्राटीन्, a variant in A, which has a defective metre.

(11) B reads शेषं ।

(12) A reads क्लिष्टिश्च, which is incorrect

चारणजारणमात्रात् कुरुते रसमिन्द्रगोपनिभम् ॥

[टीका—मुख्यत्वेन ताम्रप्रशंसनमाह—]

अथवा[1] केवलममलं कमलं दरदेन वापितं कुरुते ।
त्रिगुणं जीर्णं जीर्णं[2] लाक्षारससन्निभं सूतम् ॥

[टीका—विध्यन्तरमाह—]

रक्तागणगलितपशुजल-
बहु[3]भावितताप्यगन्धकशिलानाम्[4] ।
एकेन वापितमृतं[5]
कमलं रञ्जयति रसराजम् ॥

[टीका—रागाधिकारि-गन्धकादीनाह—]

वाञ्छो गन्धकरागो[6] विलुलितरागो[7] मनःशिलातालौ ।
माक्षीक[8]सत्त्वरसकौ द्वावेतौ[9] रञ्जने शस्तौ ॥

[टीका—प्रधानयोः ताम्रखर्परयोः सत्त्वमाह—]

क्रमहृद्धैः रविरसकैः[10] संशुद्धो मूकमूषिकाघातः[11] ।

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(1) B reads erroneously अथ ।

(2) त्रिगुणं हि जीर्णजीर्णं, a variant in B.

(3) The word बहु is omitted in B, which renders the metre defective.

(4) A reads गन्धकशिलाभिः ।

(5) A reads वापतसूतं, which seems to be incorrect

(6) A reads गंधकराग, which is incorrect

(7) A reads शितरागो । B reads विलुलितरागेण । Both the readings are grammatically incorrect.

(8) B reads माक्षिक, which mars the metre

(9) B reads द्वाव्यं हि, which seems to be incorrect.

(10) A reads क्रमहृद्धं रविरसैः । B reads क्रमहृतो रविरसको । We have adopted the above reading after collating the texts.

(11) मूषिकासुनिपात', a variant in A, which mars the metre मूकमूषिकाघातो, a variant in B.

त्रिगुणं जीर्णे जीर्णे[1] हेमाभो जायते[2] सूतः ॥

[टीका—अभ्रकयोगमाह—]

अथ[3] कृष्णाभ्रकचूर्णं पुटितं रक्तं भवेत्तथा[4] सकलम्।
त्रिगुणं जीर्णे जीर्णे[5] हेमद्रुतिसंनिभः सूतः[6] ॥

[टीका—स्वर्णमारणमाह—]

त्रिगुणेन माक्षिकेण तु कनकं च मृतं रसतालयुतम्[7] ॥
पटुसहितं तत् पक्वं हण्डिकया यावदिन्द्रगोपनिभम् ॥

[टीका—एतद्भस्मजीर्णसूतस्य लक्षणमाह—]

तच्चूर्णं सूतवरे त्रिगुणं जीर्णं हि[8] जीर्णं तु।
द्रुतहेमनिभः सूतो[9] रञ्जति लोहानि सर्व्वाणि[10] ॥

[टीका—सर्व्वेषां धातूनां रसानामुत्तरोत्तरविशेषत्वमाह—]

पत्रादष्टगुणं सत्त्वं सत्त्वादष्टगुणं द्रुतिः।

---

(1) A reads जीर्णं जीर्णं। B reads चीर्णे जीर्णे।

(2) A reads द्रुतिहेमनिभो भवेत्, (द्रुति= द्रुत)। B reads हिमवर्णाभो जायते, which mars the metre

(3) A reads अथवा, which destroys the metre

(4) A omits तथा।

(5) A reads जीर्णं जीर्णं, which seems to be incorrect B reads चीर्णे जीर्णे।

(6) हेमद्रुति(?)संनिभो भवेत् सूतः, a variant in A

(7) कनकाच्च रसताप्ययुता, a variant in A, which is a defective metre The reading of B, which we have adopted, is also a defective metre The words चेत् or स्यात् should be added after the word युतम्।

(8) A reads जीर्णे। B reads चीर्णं हि।

(9) द्रुतहेमनिभसूतो, a variant in A, which seems to be incorrect.

(10) A has जरति लोहानि सर्वाणि। B has रञ्जयति लोहानि सर्व्वाणि। Both the readings have defective metre.

द्रुतिरष्टगुणं वीजं तस्माद्‌वीजं तु जारयेत् ॥[1]

नवमः पटलः ।

[टीका—वीजप्रशंसनमाह—]

इति रक्तोऽपि रसेन्द्रो वीजेन विना न कार्यकृद्भवति ।
द्विविधं तत् पीतसितं[2] नियुज्यते सिद्धयेच्च रसम्[3] ॥

[टीका—रसोपरसधातूनां बहुविधत्वात् शोधनमाह—]

तस्य विशुद्धिर्बहुधा[4] गगनरसोपरसलोहचूर्णैश्च ।
द्विविधं वोजं तैरपि नाशुद्धैः शुध्यति कदाचिदपि[5] ॥

[टीका—अशुद्धवीजप्रभावमाह—]

यः पुनरेतैः कुरुते कर्माशुद्धैर्भवेद्रसस्तस्य ।
अव्यापकः पतङ्गो[6] न रसे न रसायने योग्यः[7] ॥

[टीका—रससंज्ञकानाह—]

वैक्रान्तकान्त[8]सस्यकमाक्षिक[9]विमलाद्रिदरदरसकाश्च[10] ।

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(1) This verse is found in A after the verse तारकदरदशिलाभि, &c (vide ante p. 336) and runs thus —

पत्राद्दष्टगुणं दत्वा सत्वादष्टगुणं द्रुति ।

द्रुतेरष्टगुणं बीजं तस्माद्वीजं तु जारयेत् ॥

(2) B reads पीतं सितं, which destroys the metre

(3) नियुषये सिद्धयेच्च रस, an incorrect variant in A नियुज्यते सिद्धमेव तत, a variant in B. Both texts are collated in our adopted reading.

(4) रसति शुद्धिर्म्भाच्या, a variant in A, wherein the first term seems to be incorrect

(5) B reads नैतत instead of कदाचिदपि । This is incorrect, since it contains two negatives.

(6) अन्यापकपतङ्गि, a variant in A, which is incorrect

(7) A reads योज्यं । B reads रसायनवने योग्यः । Both the readings are incorrect

(8) A omits कान्त ।

(9) A reads माचीक, which mars the metre.

(10) A reads दरदरसकैव ।

अष्टौ रसास्तथैषां सत्त्वानि[1] रसायनानि स्युः ॥

[टीका—उपरससंज्ञकानाह—]

गन्धकगैरिकसुशिला[2]चितिखेचरसञ्जनञ्च कङ्कुष्ठम् ।
उपरससंज्ञमिदं[3]स्यात् शिखिग्रशिनौ मारलोहाख्यौ ॥

[टीका—पूतिसंज्ञके आह—]

ताम्रारतीक्ष्णकान्ताभ्रवङ्गलोहानि[4] नागवङ्गौ च[5] ।
कथितौ च पूतिसंज्ञौ[6] तेषां संशोधनं कार्यम् ॥

[टीका—लवणक्षारसंज्ञे आह—]

सौवर्चलसैन्धवकं चूलिकसामुद्ररौमकविड़ानि ।
षड्लवणान्येतानि तु सर्जीयवटङ्कणाः क्षाराः ॥[7]

[टीका—शोधकद्रावकगणमाह—]

सूर्य्यावर्त्तः[8] कदली कन्या[9] कोशातकी च सुरदाली ।
शीग्रुश्च[10] वज्रकन्दो नीरकणा काचमाची च ॥
आमासिकरसेन तु लवणक्षारास्त्वभाविता बहुशः ।
शुद्ध्यन्ति रसोपरसा धाता मुञ्चन्ति सत्त्वानि ॥[11]

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(1) A reads चत्वारि which is not accurate.

(2) B reads शिलान्तक, which destroys the metre

(3) B reads संज्ञकमिदं, which mars the metre

(4) B reads सत्वलौहानि ।

(5) B reads वङ्गनागौ च ।

(6) B reads कथितौ कुसृतसंज्ञौ which is incorrect

(7) This verse is not found in A

(8) A reads सूर्य्यावर्त्तक ।

(9) B reads वन्ध्या ।

(10) A reads शिग्रुश्च ।

(11) This verse is found in A only.

[टीका—शोधकद्रावकाणां शोधनद्रावणविधानमाह—]

स्विन्नं सत्क्षाराम्लैः[1] ध्मातं वैक्रान्तकं हठाद्द्रवति[2]।

तद्द्रुतमात्रं[3] शुध्यति कान्तं शशरक्तभावनया ॥

[टीका—तच्चाह—]

सस्यकमपि रक्तगणैः[4] सुभावितं स्नेहरागसंयुक्तम्[5]।

शुध्यति वारैः[6] सप्तभिरतः परं युज्यते कार्ये[7] ॥

[टीका—तच्चाह—]

चारैः स्नेहैरादौ पश्चादाम्लेन[8] भावितं विमलम्।

शुध्यति तथाच रसकं दरदं माक्षीकमप्येवम्[9] ॥

[टीका—ताम्रशोधनमाह—]

तनुरविपत्रं लिप्तं[10] लवणक्षाराम्लरविक्षुकचौरैः[11]।

ध्मातं निर्गुण्डीरससिक्तं बहुशो बहेद्द्रवत्वञ्च[12] ॥

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(1) A reads सच्चाराम्ले।

(2) A reads हतद्रवति, which is incorrect

(3) A reads तद्दुतमात्रे, which is incorrect

(4) B reads रसुगणैः, which seems to be incorrect

(5) भावनतः स्नेहरागसंसिक्तं, a variant in A

(6) A reads रागैः।

(7) सप्तभिरतः परं योजयेत् कार्ये, a variant in A, which mars the metre B reads सप्तभिरभितः परं, wherein भभितः is incorrect as well as a defective metre.

(8) B reads पश्चात् सर्पेन।

(9) दरदमाक्षिकमप्येवं तथा शुद्धान्ति, a variant in A, wherein the last two words are superfluous and incorrect

(10) B reads तनुरपि पत्रलिप्तं, which has no sense

(11) A reads क्षत्रि। B reads क्षुक्षा। Both the readings destroy the metre.

(12) A reads बहुशो बहेद्द्रत्वं। B reads बहुशो द्रवत्वञ्च। Both the readings are defective.

[टीका—लोहशोधनमाह—]

शुद्ध्यति नागो वङ्गो घोषो रविणा च वारमुनिसंख्यैः[1]।
निर्गुण्डीरससेकैस्तन्मूलरजःप्रवापैश्च ॥

[टीका—तत्राह—]

रक्तागणगलितपशुजलभावितपुटितं च रज्यते[3] तीक्ष्णम्।
शुद्ध्यति कदलीशिखिरसभावितपुटितं[4] त्रिभिर्वारैः ॥

[टीका—मारणमाह—]

मर्द्यैः शुद्ध्यति लोहो रज्यति[5] सुरगोपसन्निभो वापात्।
माक्षिकसत्त्वे भृङ्ग[6] शुल्वं वा गन्धकेन हतम्[7] ॥

एकादशः पटलः।

छागास्थिभस्मनिर्मितमूषां कृत्वैवामलकाकारां।
दलयोगे घनरन्ध्रां टंकणविषगुञ्जकृतलेपां ॥

[टीका—अथ ग्रन्थकारयितुर्वंशवर्णनमाह—]

शीतांशुवंशसम्भवहैहयकुलजन्मजनितकुल[8]महिमा।

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(1) चीमी रविरीधमपि च मुनिसंख्ये:, a variant in A B reads रविणा च वारमुनिभि'। Both the readings are incorrect.

(2) B reads सिक्तैः, which is not correct.

(3) A reads रञ्जमे, which is incorrect

(4) शुद्ध्यति कदलीत्वाखिरसभावितं पुटित, an incorrect variant in B

(5) A and B read रञ्जति, which is grammatically incorrect.

(6) A reads सहस। B reads दर्दिन ष्टं। Both are unintelligible

(7) A reads शुल्वेन वा गधकेन हत। B reads मतं।

(8) कुल is not found in B

जयति श्रीमदनरथः[1] किरातनाथो रसाचार्य्यः ॥

[टीका—अथ चास्य कारयितुर्गुणवर्णनमाह—]

यस्य स्वयमवतीर्णा रसविद्या सकलमङ्गलाधारा[2] ।
परमश्रेयसहेतुः श्रेयसि परमेष्ठिनः पूर्व्वम्[3] ॥

येन चतुर्वर्णस्त्रेच्छादिव्याधादिलब्धसत्लाभम्[4] ।
दक्षिणरसा गृहीता[5] आदिवराहेणेव महाप्रलये ॥[6]

नष्टशरीरविवर्णा हीनाङ्गाः कुष्ठिनो गुणाढ्यस्य ।
अभिनवसोमेश्वरतामापुरपि पुनर्नवैरङ्गैः ॥

[टीका—कर्त्ता स्वनाममहत्त्वं सूचयन्नाह—]

तस्मात् किरातनृपतेः बहुमानमवाप्य रससुकर्म्मरतः[7] ।
रसहृदयाख्यं तन्त्र[8] विरचितवान् भिक्षुगोविन्दः[9] ॥

नत्वा मङ्गलविष्णोः सुमनोविष्णोः सुतेन तन्त्रोऽयम्[10] ।
श्रीगोविन्देन कृतः[11] तथागतः श्रेयसे भूयात् ॥[12]

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(1) स जयति श्रीमदनश्च, a variant in B,

(2) C reads सकलमङ्गलाधारा ।

(3) Of the latter half C has only परं सद्धेतु ।

(4) C reads चतुर्वर्णस्त्रेच्छादिव्यदासवध्वमलाभम्, which seems to be incorrect Cf Patala 1, in which the following verse is given --किरातगोपादिकतापसाद्यवनेचरासत्-कृषलासथान्वे । विदति नानाविधभेषजाना प्रमाणवर्णाकृतिनामजाती' ॥

(5) दक्षिणस्त्र रस गृहीता is the incorrect reading in C [In the case of किरातनाथ रसा. गृहीता. i e, collected रस—mercury, minerals, &c and दक्षिण is favorable, and in the case of आदिवराह रसागृहीता, i e, lifted up the earth]

(6) This verse and the next are not found in B.

(7) C reads रसकर्मोपदेशतां दृष्ट्वा, which destroys the metro

(8) C reads रसहृदयेशास्त्रं, which seems to be incorrect

(9) C reads विरचिताधा भगवद्गोविन्दः, which is incorrect

(10) C has रसाढ्यनाम तन्त्रोयम्, which is incorrect.

(11) C has श्रीमद्भगवद्गोविन्देन कृतं, which mars the metre

(12) This verse and the next are not found in B

अष्टादशसंस्कारं रसेन्द्रदेवस्य दिव्यतनु दृष्ट्वा ।
लिखितमिदं पुण्यतमं रसहृदयमवाप्यते सकलम् ॥

इति श्रीमद्भगवद्गोविन्दविरचितं रसहृदयं समाप्तम् ।[1]

शुभमस्तु ।

संवत् १६०४ समये ज्येष्ठ वदि १२ भौमे जगन्नाथभट्ट लेखि ॥

श्रीराम हाल संवत् १८८० पौष वदि २ भौमे ।

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(1) MS. A ends abruptly with the colophon, which runs thus :—इति श्रीगोविन्दभगवत्पादविरचिते रसहृदये जीर्णरसक्रियाधिकार एकविंशतितमः पटलः ॥ The author's account of himself is altogether wanting in it. B has "इति सकलरसवैद्यकुलकिरीटभूयायमाणारुणपादपद्मराग सकलविद्यापारीण श्रीमद्भिक्षुगोविन्दकृतौ रसहृदयः समाप्तः । इति श्रीमत्कुरलवंशपयोधिसुधाकरमिश्रमहेशात्मजश्रीचतुर्भुजविरचितायां .. . खण्डे बाला-न्वयबोधिकाख्यायां रसहृदयटीकायां रसप्रशंसात्मक एकोनविंशोऽवबोधः । इति श्रीः" ॥

Extracts from
KAKACHANDESVARIMATA.

काकचण्डेश्वरीमततन्त्रात्

समुद्धृताः श्लोकाः ।

ॐ नमः सदाशिवाय ।

कैलासशिखरासीनमुमा रुद्रं जगद्गुरुम् ।
स्कंदनंदीमहाकालौ भृंगचण्डोविनायकौ ॥ 1.
योगिनीनामष्ट तत्र गुह्याद्गुह्यतरं परम् ।
कपाली कालरात्री च कालचंद्रकलाम्बिका[1] ॥ 2.
कराली कालकर्णी च काकचण्डेश्वरी तथा ।
एवमादिस्तथा चान्या योगिनीगणगुह्यकैः[2] ॥ 3.
नृत्यवाद्यसुखेशानैः सानन्दैर्हृष्टचेतसैः ।
तत्रस्थं भैरवं देवं योगिनीगणवेष्टितम् ॥ 4.
केचित् स्तुवन्ति संहृष्टाः केचिद्गायन्ति गुह्यकाः ।
केचिन्नृत्यन्ति गुह्या ये केचिद्वाद्यं न कुर्व्वते ॥ 5.
हर्षितं[3] भैरवं देवं पंचवक्त्रं त्रिलोचनम् ।
तं दृष्ट्वा भैरवी हृष्टा जगतां त्रिदशेश्वरी ॥ 6.
कृताञ्जलिपुटा भूत्वा कृष्णतारकलोचना ।
काकचण्डेश्वरी देवी उवाचेदं तु भैरवी ॥ 7

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(1) The text reads कालचन्द्रकलम्बिका, which is incorrect.

(2) The text reads गुह्यकौ, which is incorrect

(3) The text reads हृष्टनं, which is not correct.

काकचण्डेश्वरो उवाच ।

भगवन् देवदेवेश सर्वज्ञ सर्वविच्छिव[1] ।
सर्वज्ञानप्रकाशाय अहं पृच्छामि शंकर ॥ 8
कथं कायस्थितो जीवो जीवकोऽसौ प्रकीर्त्तितः ।
कायस्थः कर्मणा केन स्थितः संसारपंजरे ॥ 9.
जराव्याधिदारिद्र्येण ग्रस्तः संसारबंधनैः ।
एको व्रजति यानेन एकः स्कंधे वहेच्च तम् ॥ 10
जयजयशब्दं मांगल्यमेकस्थाने च जंतवः ।
किं कुर्वाणाः प्रकुर्वाणाः कस्मान्मे ब्रूहि शंकर ॥ 11

श्रीसर्वज्ञ उवाच ।

शृणु त्वं काकचामंडे साधकानां हितं प्रिये ।
गुह्याद्गुह्यतरं वाक्यं पृष्टोऽहं तु वरानने ॥ 12.
कथयामि समासेन शृणु त्वं काकचंडिके[2] ।
यस्यार्थेश्च परो नित्यः अनादिनिधनेश्वरः ॥ 13.
सुरूपो निर्गुणः शांतो विश्वव्यापी परात्परः ।
अनादिकर्मसंबंधः कायस्थो भवति तु सः ॥ 14.
जीवे व्याधिभयं कर्म अज्ञानात् संप्रकीर्त्तितम् ।
तस्मात् कर्मभवात् क्लिष्टः संसारे संसरेत्तु सः ॥ 15.
करोति[3] विविधं कर्म संसारे काममोहितः ।
द्रव्योपायं न जानाति कामभोगार्थहेतुना ॥ 16
काय[4]क्लेशेन मानव्यो द्रव्योपायं करोति सः ।
कृषिवाणिज्यसेवयां सेवाविक्रयविक्रये ॥ 17.

(1) The text reads सर्वच्छिवः, which is not correct

(2) The text reads काकचने, which is incorrect

(3) The text reads करोतु, which is not accurate

(4) The text reads कानक्लेशेन, which is not correct.

वहन्ति काष्ठभारांश्च तृणभारमनेकधा ।
यानं यवनरूढं[1] च किं करोति[2] करोति सः ॥ 18.
कामासक्तानरः श्रीमान् कुरुते कर्म नैकधा[3] ।
कुर्वाणाश्च नराः केचित् कामासक्तार्थचिन्तकाः ॥ 19
जायंते मर्त्यलोकेस्मिन् दारिद्रोपहतचेतसः ।
जायंते नात्र संदेहो कुब्जखंजा नपुंसकाः ॥ 20
महासंसारबंधेन त्रिगुणेन सुयंत्रिताः ।
अटव्यां घोरसघट्टघाटिकां तु नयन्ति तत् ॥ 21.
एतत्ते कथितं भद्रे यत्त्वं मां परिपृच्छसि ।
किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ 22
इति काकचंडेश्वरीमते प्रथमः पटलः ।

श्रीकाकचण्डी उवाच ।

कथयस्व महादेव कामभोगप्रसाधनः ।
अर्थः संपद्यते येन अक्षोभात् परमेश्वर ॥ 1
तदहं श्रोतुमिच्छामि कथयस्व प्रसादतः ।
आकाशगमनं देव खेचरत्वं यथा भवेत् ॥ 2.
पादुकाया दले पंचदिव्यस्त्रोकामसाधनम् ।
रोचनं अंजनं चैव धातुवादरसायनम् ॥ 3.
जलूकाबंधमित्याहुः रसस्य मारणं कथम् ।
जारणं रत्नकर्तृत्वं वज्रभद्रावणं कथम् ॥4.
एतत् सर्वं समासेन ब्रूहि मे त्रिपुरांतक ।

श्रीभैरव उवाच ।

शृणु त्वं काकचामंडे साधकानां हितं प्रिये ॥ 5

(1) The text reads यवनरुतं, which has no sense

(2) The text reads किं कुर्वति, which is incorrect

(3) The text reads कुरु कर्मसनेकधा, which is incorrect.

कथयामि समासेन पृथक् सिद्धार्थसाधनम्।
न द्रव्येण विना सिद्धिर्न भोगाः काम एव च॥ 6
द्रव्यहीना नरा मर्त्ये प्रेतरूपेण संस्थिताः।
अटंति मर्त्यलोकेस्मिन् पर्युपद्रवकारणम्॥ 7.
* * * विर्वं (?) तेषां जायतोपि मृतस्मृतिः।
कुलं सौभाग्यरूपं च पांडित्यं ज्ञानसंस्थितम्॥ 8.
द्रव्यहीना न शोभंते प्राणहीना नरा यथा।
कुत्सितो प्राणहीनोपि केनापि वधिराः स्थिताः॥ 9
पश्यंते मर्त्यलोकेस्मिन् द्रव्यस्थं मकरध्वजम्।
तस्मात् संसाधयेद्देवि रसेन्द्रं साधकोत्तमः॥ 10.
अथातः संप्रवक्ष्यामि रसेन्द्रसाधनं तव।
मारणं जारणाद्यं च द्रव्यसाधनमुत्तमम्॥ 11.
वज्रदंडः सुदंडश्च लोहदंडस्तथैव च।
त्रयो विना औषधये रसस्य मारणे हिताः॥ 12.
तान्निबोध समासेन यथा जानंति साधकाः।
वज्रदंडस्तु वज्री स्यात् लोहदंडं पुटं विड्ः॥ 13.
सुदंडं ब्रह्मदंडं च समासात् कीर्त्तितं तव।
ग्राहयेत्तं समासेन साधको हृष्टमानसः॥ 14.
तद्रसं रससंयुक्तं एकीकृत्य तु मर्दयेत्।
अंधमूषागतं ध्मातं रसं म्रियेत तत्क्षणात्॥ 15
सहस्रवेधी कर्त्ता च जायते स महारसः।
मूषां संलेपयेत् तेन पुराग्रह्य महौषधीः॥ 16
अंधयित्वाग्निमध्ये तु रतिबंधः अयं विधिः।
पश्चात् पलसहस्रैकं शुल्वस्य ग्राहयेद्बुधः॥ 17.
अम्लवर्गहतं शुल्वं क्षारवर्गहतं शुभम्।
वज्रीक्षीरार्कक्षीरेण मर्दयेत् शतधा नरः॥ 18.
पुटं दद्यात् समासेन कालिकारहितं भवेत्।
मूषागर्भांदरे क्षिप्त्वा ध्मापयेत् खदिरानलैः॥ 19

रसेन्द्रः च्चियते तत्र तारं संजायते च्चणात् ।
अथातः संप्रवक्ष्यामि मूषाबंधं यथा भवेत् ॥ 20.
मृत्तिकाः ग्राहयेत् प्राज्ञस्तृणपाषाणवर्जिताः ।
तुषादग्धास्तथो ग्राह्या मृद्भागास्तु त्रयस्तथा ॥ 21.
एकीकृत्य तु संबंधे मूषां तत् कारयेद्बुधः ।
गोस्तनाकारसदृशीमथवामलकं कुरु ॥ 22.
मूषाबंधमिति ख्यातं साधकानां हिताय वै ।
अथान्यत् संप्रवक्ष्यामि रसस्य मारणं यथा ॥ 23
ग्राहयेत् पूर्ववद्भूयः ओषधीस्तिस्रः साधकः ।
मूषां संलेपयेत् तेन धाम्य कर्म समाचरेत् ॥ 24.
रसेन्द्रो म्रियते चिप्रं कुरु कर्म यदिच्छया ।
वीतोदकेन कामेन हेमकर्माणि वा शृणु ॥ 25.
कारयेल्लोहमयं पात्रं तस्योर्द्धे मृन्मयं शुभे ।
अन्योन्यपृष्ठसंलग्नं कारयेत् साधकोत्तमः ॥ 26.
अधोयन्त्रेण तं धाम्य आयसं तत्र जारयेत् ।
तप्तखल्वोदरे घृष्टं जरते नात्र संशयः ॥ 27.
तद्गुणं आयसं तत्र हेमं चाष्टगुणं दद्देत् ।
चौरवच्चं तथा चारो षट्जारो चद्रिग्रही । (?)
ग्राहयित्वा रसं तेषां आयसं जारयेन्नरः ॥ 28.
हेमं संजायते तत्र धर्मकामार्थसाधनं ।
गृह्य खल्वोदरे तप्ते हेमं षड्गुणतां भजेत् ॥ 29.
पुरा महौषधैर्युक्तं जरते नात्र संशयः ।
जारिते सारितं दद्यात् पुनस्तं जारयेद्यदि ॥ 30
कुरुते कर्मसंघांश्च कर्म सिद्धार्थसाधनं ॥ 31.
जारणं मारणं चैव समासात् कीर्त्तितं मया ।
किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ 32.
इति श्रीकाकचंडेश्वरीमते द्वितीयः पटलः ।

अथान्यं संप्रवक्ष्यामि अभ्रकस्य यथाक्रमम् ॥ 20.
द्रावणं अभ्रकस्यैव समासेन विधीयते ।
क्षीरकंचुकिचूर्णेन तद्रसेनाभिभावितं ॥ 21.
निर्गुण्डीवज्रदण्डं तु तद्रसे भावितं कुरु ।
एकैकं सप्तवारैस्तु भावयेत् साधकोत्तमः ॥ 22.
(भावनान्ते) अभ्रकस्य अम्ले क्षिपेद्दिनत्रयं ।
बृहत्या सप्तरात्रं तु क्षिपेदभ्रं नरोत्तमः ॥ 23.
तेन कल्केन पत्राणि लेपयेदभ्रकस्य च ।
कांस्यपात्रेण * * * स्तारे साधकोत्तमः ॥ 24.
सूर्यधाम्नि ततो धाप्यः सप्ताहं साधकोत्तमः ।
द्रवते नात्र संदेहः प्रियं दृष्ट्वा यथा स्त्रियः ॥ 25.
रसस्य भागमेकं तु द्रुतभागसमं कुरु ।
एकीकृत्य तु तद्राम्यं स्त्रियते नात्र संशयः ॥ 26
लक्षांशवेधकोऽसौ हि जायते नात्र संशयः ।
अथान्यं संप्रवक्ष्यामि यथा संजायते द्रुतिः ॥ 27
ग्राहयेदभ्रकं प्राज्ञः पीतं वा कृष्णमेव वा ।
पुरासंस्कारयुक्तं तु कर्त्तव्यं साधकेन तु ॥ 28
यवासा चित्रकं धारः कंचुकीवज्रदंडयोः ।
वज्रकंदार्कक्षीरं च भल्लातं टंकणं तथा ॥ 29.
क्षारत्रयसमायुक्तं पटुपंचसमन्वितं ।
एकीकृत्य तु कल्केन अभ्रपत्राणि लेपयेत् ॥ 30
मूषागर्भोदरे क्षिप्त्वा धामयेत् खदिरानलैः ।
द्रवते नात्र संदेहो * * * * *
इति काकचंडेश्वरीमते षष्ठः पटलः ॥

Extracts from
RASENDRACHUDAMANI.

सोमदेवविरचितात् रसेन्द्रचूडामणेः उद्धृताः श्लोकाः ।

रूप्येण सह संयुक्तं ध्मातं रूप्येण चेल्लगेत्[1] ।
तदा निरुत्थमित्युक्तं लोहं तदपुनर्भवम् ॥
एवं रूप्यं सनागं चेत् ध्मातं ताम्रे लगेन्नहि ॥

निष्कमात्रे तु नागेऽस्मिन् लोहखार्य्यां हृते सति ।
स्रुतो लक्षगुणां हैमीं शलाकां ग्रसति ध्रुवम् ॥
कुसुम्भतैलतप्तं तत् स्वर्णमुद्रिरति[2] ध्रुवम् ।
गुह्यनागोऽयमुद्दिष्टो वक्ति[3] स्वच्छन्दभैरवः ॥
तीक्ष्णं नीलाञ्जनोपेतं ध्मातं हि बहुशो दृढम् ।
मृदुकृष्णं द्रुतद्रावं[4] वरनागं तदुच्यते ॥
मृतस्य पुनरुद्भूतिः संप्रोक्तोत्थापनाख्यया[5] ।
द्रुतद्रव्यस्य निक्षेपो द्रवे तड्ढालनं मतम् ॥

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(1) The text reads लघु । But रसरत्नसमुच्चय reads लगेत्, which seems to be correct.

(2) The text reads स्वर्णं मुद्गिरिं, which is incorrect.

(3) The texts reads मुद्दिष्टशक्ति, which has no sense

(4) The text has द्रुतद्रावी, which is incorrect. We have adopted the text of रसरत्नसमुच्चय ।

(5) The text reads साधीक्तस्थापनाख्यया, which seems to be erroneous

त्रिंशत्पलमितं नागं भानुदुग्धेन मर्द्दितम् ।
विमर्द्य पुटयेत्तावत् यावत् कर्षावशेषितम् ॥
न तत् पुटसहस्रेण क्षयमायाति सर्व्वथा[1] ।
चपलोऽयं समुद्दिष्टो वार्त्तिकैर्नागसम्भवः[2] ॥
इत्थं हि चपलः[3] कार्य्यो वङ्गस्यापि न संशयः ।
तत्स्पृष्टहस्तसंस्पृष्टः केवलो वध्यते रसः ॥
स रसो धातुवादेषु शस्यते न रसायने[4] ।
अयं हि खर्पणाख्येन[5] लोकनाथेन कीर्त्तितः ॥
श्यामकाख्यरजः सूक्ष्मं पञ्चमांशरसान्वितम् ।
कुमारीमूलतोयेन मर्द्दयेदेकवासरम् ॥
चाङ्गेरीस्वरसेनापि दिनमेकमनारतम्[6] ।
एवं भूनागघातेन मर्द्दयेद्दिवसद्वयम् ॥
अथैकपलमानेन तावता त्रपुणापि च ।
दशनिष्करसेन्द्रेण सम्यक्पिष्टीं समाचरेत् ॥
योजयित्वाथ कल्केन यथापूर्व्वं विमर्द्दयेत् ।
ततः साररसेन्द्रेण सत्त्वेन रसकस्य च ।
पिष्टीं कृत्वा तु पूर्व्वेण पूर्व्वकल्केन योजयेत् ॥
अथ प्रक्षाल्य कोष्णेन[7] काञ्जिकेन प्रशोषयेत् ।

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(1) The text has क्षयमायान्ति सर्व्वदा, which is grammatically incorrect

(2) The text reads मार्गसंभवः, which is incorrect

(3) The text reads इत्थं चौरपलः, which is senseless.

(4) The text has रसायनम् ।

(5) खर्वणाख्येन is the reading in रसरत्नसमुच्चय ।

(6) The text reads दिनमेकमनारसम्, which has no clear sense

(7) The text reads सौष्ठेन, which is unintelligible.

पलार्द्धशुद्धसत्त्वेन भ्रष्टगुञ्जारसेन च ।
विमर्द्य काञ्जिके कुर्य्यात् मरिचप्रमितां गुटीम्[1] ॥
निरुध्य वज्रमूषायां सन्धिबन्धं विधाय च ।
शुषिरैर्नवभिः[2] सम्यग्भस्त्राभ्यां च धमेत् खलु ॥
ततो मूषागतं सत्त्वं समादाय समन्ततः ।
धमेत् प्रकटमूषायां वङ्कनालेन शुद्धये ॥
दग्धशाणं हि तत्सत्त्वं भस्मना लवणेन च ।
सकाञ्जिकेन संवेष्ट्य पुटयोगेन शोधयेत् ॥
द्विनिष्कप्रमिते तस्मिन् पूर्व्वप्रोक्तेन भस्मना ।
अशीतिगुणितं नागं ध्मात्वा निर्वाहयेत् खलु ॥
द्रयता[3] पूर्व्वसूतोऽसौ जीयते न कथञ्चन ।
चपलोऽयं समुद्दिष्टो लोकनाथेन शम्भुना ॥
अनेनापि रसः शीघ्रं बध्यते पूर्व्ववत् खलु ।
कारवल्लीजटाचूर्णैर्दशधा पुटितो हि सः ।
भवेन्नागविनिर्म्मुक्तो ग्रासं रङ्क्षात्यशेषतः ॥
सुखं प्रकटमूषायां भवेच्च त्रिगुणोत्तरम्[4] ।
जीर्णग्रासो रसोह्येष देहलोहकरो भवेत् ॥
सोऽयं श्रीसोमदेवेन कथितोऽतीव निश्चितम् ॥
भूभुजङ्गमक्षत्तोयैः[5] प्रक्षाल्यापहृतं[6] रजः ।
कृष्णवर्णं हि तत् प्रोक्तं धौताख्यं[7] रसवादिभिः ॥

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(1) The text reads मरिचप्रमिता गुटी, which is incorrect

(2) The text reads शिशिरैर्नवभि., which has no sense

(3) The text reads द्रयसा, which is incorrect

(4) The text reads त्रिगुणोत्तरा, which is incorrect.

(5) The text reads तोये, which is not accurate

(6) The text has अपहृतं, which is not accurate

(7) The text reads धौताख्ये, which is not correct

स्वरूपस्य विनाशेन पिष्टतापादनं हि यत् ।
विप्रुड्भिर्वर्जितः[1] सूतो नष्टपिष्टः स उच्यते ॥
अथ यन्त्राणि वक्ष्यन्ते रसतन्त्राण्यनेकशः[2] ।
समालोक्य समासेन सोमदेवेन सांप्रतम् ॥
ऊर्ध्वपातनयन्त्रं हि नन्दिना परिकीर्त्तितम् ॥

कोष्ठि(ष्टि)कायन्त्रमेतद्धि नन्दिना परिकीर्त्तितम् ॥

विन्ध्याद्रौ हिमपर्व्वते च मलये गोमन्तके श्रीगिरौ
सह्याद्रावथ पारियात्रकगिरौ किंकिंधिनामालये ।
माहेन्द्रेऽप्यथ चाल्पवत्चितिधरे तद्रूपनामाधिकं
गोपाभीरकसिद्धवैद्यमुखतो वैद्यः समाविद्यताम् ॥

इति श्रीकरवालभैरवपुरवरपतिश्रीसोमदेवविरचिते
रसेन्द्रचूडामणौ रससूत्रस्थाने रसमहिम-
निरूपणं नाम प्रथमोऽध्यायः
समाप्तः ।

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(1) But रसरत्नसमुच्चय reads विद्भिर्निर्जित' ।

(2) But रसरत्नसमुच्चय reads च्चशेषत' ।

Extracts from

RASAPRAKASASUDHAKARA.

यशोधरविरचितात् रसप्रकाशसुधाकरात् उद्धृताः श्लोकाः ।

विमलसूतवरो हि पलाष्टकं
तदनु धातुघटीपटकांचिकाः ।
पृथगिमाश्च चतुःपलभागिकाः
स्फटिकाशुद्धपलाष्टसमन्विताः ।
सह जलेन विमर्द्य च यामकं
लवणकाम्लजलेन विमिश्रितम् ।
उदितधातुगणस्य च मूषिकां
कुरु रसं विनिवेश्य तत्र वै ।
डमरुकाभिधयन्त्रवरेण तं
द्विदशयाममजाचयवह्निना ।
पवनपित्तकफक्षयकारकं
सकलरोगहरं परमं सदा ।
गजपतेर्बलवद्बलदो नृणां
द्विजपतीक्षणवन्नयनप्रदः ।
युवतिकामविलासविधायको
भवति सूतवरः सुखदः सदा ।
सवनसाररसः किल कान्तिद-
स्त्वखिलकुष्ठहरः कथितो मया ॥

इति कर्पूररसः ॥

उदयभास्करनामरसो ह्ययं
भवति रोगविधान्तकरः स्वयम् ।

मृगधिकामधुना सह गुञ्जिका-
वर्यमितश्च मदा परिसेवितः ।
ललितकामविलासविधायकः
स्थविरकोऽपि रतौ तरुणायते ॥
गदहरो बलदोऽपि हि वर्णदो
भवति कर्म्मविपाकजरोगहा ।
सकलसूतकशास्त्रविमन्यजो
द्विजवरेण मया प्रकटीकृतः ॥

इति उदयभास्कररसः ॥

अथेदानीं प्रवक्ष्यामि धातुशोधनमारणम् ।
अनुभूतं मया किञ्चित् शिश्विच्छास्त्रानुसारतः ॥
सुवर्णं रजतं चेति लोहं शुद्धमुदीरयेत् ।
ताम्रं चैवाश्मसारञ्च नागवङ्गौ तथैव च ॥
तीक्ष्णलोहं निगदितं त्रितयं रसवेदिभिः ।
समिश्रलोहत्रितयं सौराष्ट्रीतिवर्त्तकाः ।
एतेऽष्टौ धातवो ज्ञेया लौहान्येवं भवन्ति हि ॥

अथ रसकगुणाः ।

द्विविधो रसकः प्रोक्तः कारवेल्लज-दर्दुरः[1] ।
सत्त्वपाते परः प्रोक्तः प्रथमश्चौषधादिषु ॥
स तु[2] मेहहरश्चैव पित्तश्लेष्मविनाशनः ।
रञ्जनः पारदस्याथ नेत्ररोगक्षयापहः[3] ॥

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(1) The text reads काली वमदुर्दुर, which appears to be incorrect

(2) The text reads हत, which seems to be incorrect.

(3) The second hemistich is wanting in the text. We have adopted the reading of रसरत्नसमुच्चय ।

पारदो रसकश्चैव देहलोहकरावुभौ ।
नागार्ज्जुनेन कथितौ सिद्धौ श्रेष्ठौ रसावुभौ ॥
ज्ञातौ येनाग्निसहनौ सूतखर्परकौ शुभौ ।
तेन स्वर्णमयी सिद्धिरर्जिता[1] च न संशयः ॥
रसको द्रावितः सम्यक् निक्षिप्तो रसपूरके ।
निर्मलत्वमवाप्नोति सप्तवारं निमज्जितः[2] ॥
काञ्जिके वाथ तक्रे वा नृमूत्रे[3] मेषमूत्रके ।
द्रावितं चालितं[4] सम्यक् खर्परं परिशुध्यति ॥
खर्परं रेचितं शुद्धं स्थापितं नरमूत्रके ।
रञ्जयेन्मासमेकं हि ताम्रं स्वर्णप्रभं वरम् ॥
वचाहरिद्रात्रिफला-गृहधूमैः ससैन्धवैः ।
भल्लातकैष्टङ्कणैश्च क्षारैराम्लैश्च मर्द्दितम्[5] ॥
पादांशसंयुतैर्मूषां वृन्ताकफलसन्निभाम् ।
निरुध्य शोषयित्वा च मूषामुखोपरि न्यसेत् ॥
प्रध्माते खर्परे ज्वाला सिता नीला भवेद्यदि ।
लोहसंदंशके मूषां धृत्वा कृत्वा ह्यधोमुखीम् ॥
भूम्यामाढालयेत् सत्त्वं यथा नालं न भज्यते ।
तदा सीसोपमं[6] सत्त्वं पतत्येव न संशयः ॥
अनेनैव प्रकारेण वारत्रयकृते सति ।
विनिःसरेत् सर्व्वसत्त्वं सहिंगु(?) गुरुणोदितम् ॥

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(1) The text reads सिद्धौ राजिता, which is not accurate.

(2) The text reads निमज्जितं, which is incorrect

(3) The text has only मूत्रे, which mars the metre.

(4) द्राविते चालिते is the reading of the text, which is evidently an error.

(5) The text reads वर्जित, which seems to be incorrect.

(6) रसरत्नसमुच्चय says वङ्गाभं । See Chap. II. Verse 161.

अथ सौराष्ट्रीगुणाः ।

सौराष्ट्रदेशे सञ्जाता खनिजा[1] तुवरी मता ।
या लेपिना स्वेतवस्त्रे रङ्गबन्धकरी हि सा ॥
फुल्लिका स्फटिका[2] तद्वत् द्विप्रकारा प्रशस्यते ।
किञ्चित् पीता च सुस्निग्धा गरदोषविनाशिनी ॥
स्वेतवर्णा परा मान्या फुल्लिका लोहमारणी ॥
कषाया मधुरा कान्ती कटुका विषनाशिनी ।
व्रणघ्नी कफघ्ना चैव नेत्ररोगापहारिणी ॥
कण्ठरोगहरा सा तु पारदे वीजजारणी ।
धान्याम्ले तुवरी क्षिप्ता शुध्यति त्रिदिनेन वै ॥
क्षारैरम्लैश्च मर्दिता धाता सत्त्वं विमुञ्चति ।
तत् सत्त्वं धातुवादार्थे चौषधे नोपपद्यते ॥

अथ पुटानि लिख्यन्ते ।

भूम्यां वै खन्यते गर्त्तं द्विहस्तं चतुरस्रकम् ।
छगणेन सहस्रेण पूरयेत्तदनन्तरम् ॥
औषधं धारयेन्मध्ये तदाच्छाद्य वनोपलैः ।
सहस्रार्द्धेन वै सम्यगवह्निं प्रज्वालयेत्ततः ॥
महापुटमिदं प्रोक्तं ग्रन्थकारेण निश्चितम् ॥

इति महापुटम् ॥

एकहस्तप्रमाणं हि चतुरस्रं च गर्त्तकम् ।
वनोपलसहस्रेण गर्त्तमध्यं च पूरितम् ॥
मूषिकां चौषधेनाथ पूरिता तां तु मुद्रयेत् ।
गर्त्तमध्ये निधायाथ गरिष्ठानि[3] च निक्षिपेत् ॥

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(1) The text reads खनिता, which is incorrect

(2) रसरत्नसमुच्चय says स्फटी फुल्लिका ।

(3) रसरत्नसमुच्चय reads गिरिण्डानि ।

ऊर्द्धाग्निं ज्वालयेत् सम्यक् सोऽयं गजपुटो भवेत् ॥

इति गजपुटः ॥

उपलं पिष्टकं छागमुत्पलञ्च गरिण्डकम् ।
छगणोपलसारौ च तचरा[1] छगणाभिधाः ॥
अरत्निमात्रे कुंडे च वाराहपुटमुच्यते[2] ॥

इति वाराहपुटः ॥

वितस्तिद्वयमानेन गर्त्तं चैवचतुरस्रकम्[3] ।
कुक्कुटाख्यं पुटं विद्यादौषधानाञ्च साधनम् ॥

इति कुक्कुटपुटः ॥

छगणैरष्टभिः सम्यक् कपोतपुटमुच्यते ॥

इति कपोतपुटः ॥

तुषैर्वा गोवरैर्वापि रसभस्मप्रसाधनम् ।
माणिकाद्वयमानेन गोवरं पुटमुच्यते ॥

इति गोवरपुटः ॥

मृद्भाण्डे तु प्रपूर्य्यैव मध्ये द्रव्यं तु विन्यसेत् ।
अधस्ताज्ज्वालयेदग्निं मृद्भाण्डपुटमुच्यते ॥

इति (मृद्)भाण्डपुटः ॥

गर्त्तं तु वालुकापूर्णं मध्ये द्रव्यं तु विन्यसेत् ।
उपरिष्टादधस्ताच्च वह्निं कुर्य्यात् प्रयत्नतः ।
तद्वालुकापुटं सम्यगुच्यते शास्त्रकोविदैः ॥

इति वालुकापुटः ॥

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(1) रसरत्नसमुच्चय reads वराटी ।

(2) The text reads अभिमात्रेण कुंडे च वाराहपुटमध्यतः, which seems to be incorrect

(3) The text reads गर्ते कुर्य्याच्चतुरस्रकं, which mars the metre

मूषिकां भूमिमध्ये तु स्थापितां द्व्यङ्गुलादधः ।
उपरिष्टात् पुटं दद्यात्[1] तत् पुटं भूधराभिधम् ॥

इति भूधरापुटः ॥

गोवरैर्वा तुषैर्वापि मात्राकर्षमितैः पुटम् ।
यत्र तल्लावकाख्यं स्यान्मृदुद्रव्यस्य साधने ॥

इति लावकापुटः ॥

इति श्रीपद्मनाभसूनुश्रीयशोधरविरचिते
रसप्रकाशसुधाकरे दशमोऽध्यायः ।

अथातः संप्रवक्ष्यामि धातूनां कौतुकं परम् ।
स्वानुभूतं मया किञ्चित् श्रुतं यच्छास्त्रतः खलु ॥
तदहं कथयिष्यामि यत् कृत्वा ना सुखी भवेत् ॥
रसकं दरदं ताप्यं गगनं कुनटीसमम् ।
रक्तस्नुहीपयोभिश्च मर्दयेद्दिनसप्तकम् ॥
जलयन्त्रेण वै पाच्यं चतुर्विंशतियामकम् ।
तेन वेध्यं द्रुतं ताम्रं तारं वा नागमेव वा ॥
सहस्र(शत)वेधी तु तत्कल्को जायते नात्र संशयः ॥
एकभागस्तथा सूतो वज्रवल्ल्याथ मर्दितः ।
स्वर्णे त्रिनिष्पाच्य रसे पञ्चभागसमन्विते ।
वेत्रयष्ट्या च रागिण्या पीतकल्कं प्रजायते ॥
षोडशांशेन दातव्यं द्रुते ताम्रे सुशोभने ।
जायते प्रवरं हेम शुद्धं वर्णचतुर्दशम् ॥

इति हेमक्रिया ॥

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(1) The text reads दत्वा, which is incorrect.

स्वर्णमाक्षिकं संस्वेद्य काञ्जिके दिवसत्रयम् ।
चर्म्मरंग्या(गा)रसेनैव मर्द्दयेद्दिनसप्तकम् ।
जलेन धौतं तावच्च यावद्धेमनिभं भवेत् ॥
दरदं रसदंशीयं[1] गोमूत्रेनैव स्वेदयेत् ।
दोलायन्त्रेऽह्नि[2] चत्वारि पश्चाच्छुद्धतमो भवेत् ॥
मनःशिला पद्मनिभा रक्ता चैव सुशोभना ।
स्वेदिता मुनिपुष्पस्य रसेनैव तु दोलया ।
याममर्द्दमिता शुद्धा सर्व्वकार्य्येषु योजयेत् ॥
नवसारस्तथा सूतः शोधितोऽग्निमति स्थले ।
समभागानि सर्व्वाणि मर्द्दयेन्निम्बुकारसैः ॥
मातुलुङ्गरसेनैव कुमारीसुरसेन वा ।
सूर्य्यातपे विमर्द्दोऽसौ पाचितो जलयन्त्रके ।
दिनानि त्रीणि तीव्राग्नौ कुर्य्यात्तदवतारयेत् ॥
शतांशं वेधयेत्तारं शुद्धहेम प्रजायते ।
जलभेदो यदा न स्यान्नात्र कार्य्या विचारणा ॥
शिलया मारितं नागं कुमार्य्याः स्वरसेन तु ।
पुटद्वादशयोगेन नागभस्म प्रजायते ॥
शतसंख्यानि वै कुर्य्यात् पुटान्येवं शरावके ।
कुमार्य्याः स्वरसेनैव भावयेद्दिनसप्तकम् ।
पूर्व्ववत् पुटनं कार्य्यं शतसंख्यामितं तथा ।
सूतगन्धशिलाटङ्कसमं चेन्नागभस्मकम् ।
त्रिंशद्वनोपलैर्द्दद्यात् पुटं वाराहसंज्ञकम् ॥
अनेन विधिना सम्यक् शतसंख्यानि दापयेत् ।
पुटान्येवं कृते त्रीणि शतानि द्वादशाधिकम् ॥

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(1) The text reads रसदंशीयौ, which is incorrect.

(2) अह्नि [अह्नानि] is grammatically incorrect

पञ्चाहे काचमये कूपे शार्ङ्गियामकम् ।
वालुकाग्निं प्रदद्याच्च स्वाङ्गशीतं समुद्धरेत् ॥
तद्भस्म ग्रहीतव्यं वैद्यैस्तारसुहृत्कृते ।
शुद्धिम भवेत्तेन नात्र कार्या विचारणा ।
दृष्टप्रत्ययप्रयोगोऽयं कथितो नात्र संशयः ॥

Extracts from

RASACHINTAMANI

मदनान्तदेव सूरिविरचितात् रसचिन्तामणेः उद्धृताः श्लोकाः ।

सैन्धवं तोरिकां सूतं कासीसं लकुचद्रवैः ।
विमृद्य खल्वभाण्डस्थं सर्वश्लक्ष्णं दिनत्रयम् ॥ 76.
हण्डिकायां तदारोप्य काष्ठवह्निर्विधीयते ।
दिनत्रयेऽप्यतिक्रान्ते भस्म श्वेततरं भवेत् ॥ 77.

*　　*　　*　　*　　*　　*　　*

इति त्रयोदश भस्मसूतः ।

खर्परो द्वादशांशः स्यात् शिखिग्रीवं च तुत्थकं ।
षड्गुणं माक्षिकं नेत्रभागं ग्राह्यं मनःशिला[1] ।
भागत्रयमिदं ग्राह्यं शोभनागतकर्करैः[2] ॥ 38
गंधकत्रयमेवास्ते काचमाचौरसैर्भृशं ।
दिनसप्तात्र कर्त्तव्या भावना मर्द्दनं क्रमात् ॥ 39.
अधोमुखेन यन्त्रेण तेन निःसारयेद्बुधः ।
सत्वं तद्रसकस्याथ दृढं कार्य्यकरं परं ॥ 40
अवश्यं तद्दृढं सत्वं निर्धूमं कर्मसाधनं ॥

इति रसकसत्वपातनं ।

त्रिवारं गन्धकहृतं ताम्रहेमद्वयत्रयं ।
सत्वं तालस्य मासैकं योजयेत् सर्वकामदं ॥ 43.

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(1) चापि नेत्रभागा मनःशिला is the correct reading as stated in the margin of the text

(2) त्रयो भागा अपि ग्राह्या शोभना गतकर्करा. is the correct reading as stated in the margin of the text.

अभ्रवर्णं भवेद्धेमं ताम्रगंधकमारितं ।
एतयोर्दीयते रम्यं जायते कांचनं शुभं ॥ 44.

इति श्रीमदनांतदेवविरचिते रसचिंतामणौ
हेमीकरणप्रयोगः ॥

पारदं सीसकं गंधं कुनटी तच्चतुष्टयं ।
बीजपूरांभसा पिष्ट्वा बाढं दिनचतुष्टयं ॥ 108.
अथ सूक्ष्माणि पत्राणि तेन तारस्य लेपयेत् ।
बीजपूररसेनैतत् त्रतिमात्राग्नितापितं ॥ 109.
एकाधिका भवंत्यत्र भावनास्वास्य विंशतिः ।
विंशोष्वावर्त्तितं तारं भवेत्तारस्य कांचनं ॥ 110.
इति चिंतामणौ हेमीकरणप्रयोगः ॥

हेमभागद्वयं तारं तथा ताम्रं चतुष्टयं ।
एकतः क्रियते पत्रमतिसूक्ष्मं निरामयं ॥ 111
जंबीरनीरसंपिष्टं खर्परस्याष्टटंकणं ।
तेन तान्यथ पत्राणि लेपनीयानि वै बहु ॥ 112
आवर्त्तते पुनर्दत्त्वा मूषके गलितानि च ।
तदा तानि भवंत्यत्र हेमरूपाणि नान्यथा ॥ 113
इति हेमीकरणप्रयोगः ॥

एकभागो भवेद्दारः तारं भागद्वयं भवेत् ।
वेदभागं भवेत्तीक्ष्णं सत्वं सत्वाच्च वै दश ।
वंगभागं भवेत्पत्रं सर्वमेकत्र कारयेत् ॥ 109.
टंकणेन पुनः ध्मातं पत्रं सत्वास्य वल्लगं ।
वेलात्रयमिदं ध्मातं तक्रमध्ये निवेशयेत् ॥ 110.
एवं तारं भवेन्नूनं परीक्षाक्षममापणे ॥
इति तारोत्पादकं ॥

तुत्थकं पिष्यते खल्वे त्रिफलाहिंगुटंकणैः ।
मध्वाज्यमिश्रितं ध्मातं सत्वं पातयते ध्रुवं ॥ 69.

इति तुत्थकसत्वपातनं ॥

खर्परः स्विद्यते पूर्व्वं कौलत्थेन जलेन च ।
वटारोहजलेनापि पर्णचूर्णेन शोभनः ॥ 75.
गुड़टंकणसंमिश्रस्त्रिफलाक्काथमर्दितः ।
मृन्मये कूपके क्षत्वा ध्मास्यमानो भृशं च सः ॥ 76.
श्वेतधूमोद्गमे जाते तत उत्थाप्य कूपकं ।
सावधानं करेणैव भूमौ तं चाध आनयेत् ॥ 77.
पुनश्च धम्यते कूपः तथाजातं च तं पुनः ।
कूपकं च पुनर्भूमौ तथा तं नामयेत् पुनः ॥ 78.
सत्वं खर्परकस्यैतत् नागरूपं पतत्यधः ॥ 79.

इति खर्परसत्वपातनं ॥

Extracts from RASAKALPA.

रुद्रयामलान्तर्गतात् रसकल्पादुद्धृताः श्लोकाः ।

शिवं नत्वा रसाधीशं चण्डिकाचरणं तथा ।
क्रियते[1] रसकल्पोऽयं रसज्ञानविशारदः[2] ॥ 1

॥ अथ परीक्षा ॥

अतेजा अगुरुः शुभ्रो लोहहा(ऽ)चञ्चलो रसः[3] ।
यदा[4] नावर्त्तयेदङ्गौ नोर्द्ध्वं गच्छेत्तदा मृतः ॥ 10

दन्ते शृङ्गे मणौ वेणौ रचयेत् साधितं रसम् ॥ 12

इति श्रीरुद्रयामले रससंकेतकं नाम
प्रथमोल्लासः ।

हेमरूप्यार्कवङ्गाहि[5]लोहा लोहाः[6] षडीरिताः ।
अकृत्रिमा इमे येषां वर्त्ताद्याः स्युस्तु[7] कृत्रिमाः ॥ 1.

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(1) The text reads करोति which is grammatically incorrect
(2) The reading in the text is विशारदम्, which is incorrect
(3) The text reads रस, which is incorrect
(4) The text reads यदानावर्त्तयेत्, which is not correct.
(5) The text reads वङ्गाहि, which is grammatically incorrect
(6) लोहिर्लोहा is the reading of the text, which seems to be incorrect
(7) The text reads र्वर्त्ताद्यास्तुकृत्रिमा, which is palpably an error

सन्तो बद्धाञ्जलिपुटो युष्मान् विज्ञापयाम्यहम् ।
कृपासुधारसयुता दृष्टिर्ग्रन्थे प्रदीयताम् ॥
महारसाः स्युस्तत्रादावष्टौ पारदहिङ्गुले ।
वैष्णवं शस्यकं शैलं चपलं रसकोऽमलम् ॥

(महारसाः)

अभ्रकं तुत्थकं कान्तं राजावर्त्तमथाञ्जनम् ।
वज्रं वैक्रान्तकं चैव टङ्कणं च रसा बहु ॥

(रसाः)

गन्धकं तालकशिले क्षितिखेचरगैरिकाः ।
इत्यादयश्चोपरसाः सर्व्वाचार्य्यैरुदीरिताः ॥

(उपरसाः)

सितासितारुणं पीतं गन्धकं तच्चतुर्विधम् ॥
तालकं द्विप्रकारं स्यात् गोदन्तः पाटलच्छविः[1] ॥
रक्ता पीता शिला द्वेधा पूर्व्वा श्रेष्ठोत्तराधमा[2] ॥
बहुप्रकारा सौराष्ट्री कासीसं त्रिविधं मतम्[3] ॥
कासीसं पुष्पकासीसं हीरकासीसमित्यथ ॥
गैरिको द्विविधः प्रोक्तः सौवर्णो लोहितस्तथा ॥
कङ्कुष्ठादीन्[4] रसान् केचिदाचार्य्या वर्णयन्ति वै ।
अस्माभिरिह तन्नोक्तं मुनिमार्गानुसारिभिः ॥

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(1) The text reads पटलाछवि, which seems to be incorrect.

(2) पूर्वा श्रेष्ठोत्तमाधमा is the reading of the text, which is incorrect.

(3) The text reads कासीसस्त्रिविधो मतः. which is incorrect, as it is mentioned neuter in the next line.

(4) The text reads कंकुष्टादीन्, which is an error of the scribe.

इत्येष प्रोदितो मार्गो रसशोधनकर्मणि ।
स्वच्छन्दभैरवाद्युक्तो गोविन्दादिसमाहृत:[1] ॥

लवणं चलिकोद्भूतं गन्धकेन समन्वितम् ।
सर्वाङ्गदस्य[2] चित्राद्रं मूलभस्मप्रगालितम् ॥
गोमूत्रेण श्रुतं भाव्यं तद्रसे जारयेत् शनैः[3] ।
तस्य संपर्कतः सूतो राक्षसो भवति ध्रुवम् ॥
एतदेव विड़ं दद्यात् सर्व्वदा हेमजारणे[4] ।
सुखं संजायते तेन जीर्यते च[5] विनिश्चितम् ॥
इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे
रसशोधनप्रकारः ॥

इति संधानयोगोऽयं जारणेऽतिगुणावहः ।
प्रकाशितः संप्रदायक्रमप्राप्तः शिवोदितः ॥
इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे
रसाधिकरणो[6] नाम द्वितीयोल्लासः ॥

महारसानां सर्व्वेषां रसाना शुद्धिरुच्यते ।
तथैवोपरसानाञ्च शास्त्रदृष्टेन वर्त्मना ॥ 1

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(1) The text reads समाहित , which is incorrect

(2) The text reads सर्वागदस्य, which seems to be incorrect

(3) शनि:, as given in the text, is grammatically incorrect

(4) The text reads हेमजारणौ, which is not correct.

(5) The text reads न, which appears to be an error

(6) The text reads रसाधिकारिणा, which is incorrect

कदलीपत्रजैर्नीरैः माक्षीकं भावयेत् शतम्[1]
गन्धर्वतैलमध्वाज्य—पक्वमेकं दिनत्रयम् ॥
तत्ताप्यं[2] वज्रमूषायां पक्वायां निक्षिपेत्ततः ।
लोहसन्धानकरणं तत्समं तत्र निष्पचेत् ॥
दृढां प्रकल्पयेन्मूषां[3] कोष्ठिके[4] विनिवेशयेत् ।
अङ्गारैः खदिरोद्भूतैः धमेद्भस्त्राद्वयेन वै ॥
वङ्कनालयुजा सत्त्वं ताप्यस्य पतति ध्रुवम् ॥
शुक्लदीप्तिः सशब्दश्च[5] यदा वैश्वानरो भवेत् ।
तदा सत्त्वं तु पतितं जानीयान्नान्यथा क्वचित् ॥

रसकं स्वेदयेदादौ[6] पटुचूर्णकृतं बुधः ।
चतुर्गुणेन वस्त्रेण दृढं वध्वा च डोलिकाम् ॥
कृत्वा भाण्डे च सजले[7] स्वेदयेन्मासपञ्चकम् ।
उद्धृत्य पश्चाद्रसकं खल्लमध्ये[8] विचूर्णयेत् ॥
पाटीशान् मालतीजातं सगुडं जीर्णगुञ्जकम् ।
रटहृष्मं रेवकीं च निशामं कुलजीरकान्[9] ॥
तत् सर्व्वं चर्णितं कृत्वा गोपंचकविभावितम् ।
कृत्वा तद्वटिकाः पश्चात् छायायां शोषयेत्ततः ॥

(1) The text reads शल्लं, which is senseless
(2) ततत्ताप्यं वज्रमूषा is the reading of the text, which appears to be incorrect
(3) The text प्रक्कल्पेन्मूषा is evidently incorrect
(4) कोष्टिकानि निवेशयेत् is the reading of the text, which has no meaning at all
(5) The text reads सशब्दस्य, which is grammatically incorrect
(6) रसकाद्यदयेदादौ is the reading of the text, which seems to be incorrect
(7) कृत्वा भाण्डे न सजले is the reading of the text, which is incorrect.
(8) The text reads खल्वमध्ये ।
(9) The text has जीरका, which is grammatically incorrect.

कोष्ठगेनाग्निना[1] पश्चाद्धमेद्भस्त्राद्वयानिलैः ।
सत्वं पतत्यसंदेहं स्थिररङ्गं दृढं बहु ॥
एकमासं द्विमासं वा रसकं स्वेदितं यदि ।
न ध्मातव्यं तच्च कोष्ठे धमेत्तत् नालमूषया ॥

इति सम्पादितो मार्गो द्रुतीनां पातने स्फुटः ।
साक्षादनुभवैर्दृष्टो न श्रुतो गुरुदर्शितः ॥
लोकानामुपकाराय एतत् सर्व्वं निवेदितम् ।
सर्व्वेषां चैव लोहानां द्रावणं परिकीर्त्तितम् ॥

इति श्रीरुद्रयामले रसकल्पे उमामहेश्वरसंवादे
सर्व्वलोहद्रुतिपातनाधिकारः समाप्तः[2] ॥

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(1) The text reads कोष्टकेनाग्निना, which is not correct

(2) समाप्तं शुभम् is the reading of the text, which is not correct

Extracts from
RASARATNASAMUCHCHAYA.

B. = Benares Manuscript.
K. = Kásmír Manuscript.

अथ प्रथमोऽध्यायः ।

रसोत्पत्तिः ।

यस्यानन्दभवेन मङ्गलकलासम्भावितेन स्फुर-
द्धाम्ना सिद्धरसामृतेन करुणावीक्षासुधासिन्धुना ।
भक्तानां प्रभवप्रसंहृतिजरारागादिरोगाः क्षणा-
च्छान्तिं यान्ति जगत्प्रधानभिषजे तस्मै परस्मै नमः ॥ 1.

आगम[1]श्चन्द्रसेनश्च लङ्केशश्च विशारदः ।
कपाली मत्तमाण्डव्यौ भास्करः शूरसेनकः ॥

रत्नकोषश्च[2] शम्भुश्च सात्त्विको नरवाहनः ।
इन्द्रदो गोमुखश्चैव कम्बलिर्व्याडिरेव च ॥
नागार्जुनः सुरानन्दो नागबोधिर्यशोधनः ।
खण्डः कापालिको ब्रह्मा गोविन्दो लम्पको हरिः ॥
सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।
रसाङ्कुशो भैरवश्च नन्दी स्वच्छन्दभैरवः ॥

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[1] आगमः, a variant in the Poona ed , which also agrees with B and K
[2] अघोरश्च, another reading in the Poona ed , which also agrees wit

मन्थानभैरवश्चैव काकचण्डीश्वरस्तथा ।
वासुदेव ऋष्यशृङ्गः[1] क्रियातन्त्रसमुच्चयो ॥
रसेन्द्रतिलको योगी भालुकी मैथिलाह्वयः ।
महादेवो नरेन्द्रश्च वासुदेवो हरीश्वरः[2] ॥ 2-7
एतेषां क्रियतेऽन्येषां तन्त्राण्यालोक्य सङ्ग्रहः ।
रसानामथ सिद्धानां चिकित्सार्थोपयोगिनाम् ॥
सूनुना सिंहगुप्तस्य रसरत्नसमुच्चयः ।
रसोपरसलोहानि यन्त्रादिकरणानि च ॥
शुद्ध्यर्थमपि लोहाना तन्त्रादिकरणानि च ।
शुद्धिः सत्त्वं द्रुतिर्भस्मकरणञ्च प्रवक्ष्यते ॥ 8-10.
हन्ति भक्षणमात्रेण पूर्वजन्मार्जितं ... ।
रोगसङ्घमशेषाणां नराणां नात्र संशयः ॥ 26.
यश्च निन्दति सूतेन्द्रं शम्भोस्तेजः परात्परम् ।
स पतेन्नरके घोरे यावत्कल्पविकल्पनाम् ॥ 29.
पतितो दरदे देशे गौरवाद्वह्निवक्त्रतः ।
स रसो भूतले लीनस्तत्तद्देशनिवासिनः ।
तां मृदं पातनायन्त्रे क्षिप्त्वा सूतं हरन्ति च ॥ 89-90.

इति श्रीवैद्यपतिसिंहगुप्तस्य सूनोर्वाग्भटाचार्यस्य
कृतौ रसरत्नसमुच्चये रसोत्पत्तिर्नाम प्रथमोऽध्यायः ।

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(1) ऋष्यशृङ्ग., a different reading in the Poona ed, which also agrees th and K.

(2) K reads रत्नाकरहरीश्वरौ, which is probably the correct reading

अथ द्वितीयोऽध्यायः ।

महारसाः ।

अभ्रवैक्रान्तमाक्षीकविमलाद्रिजसस्यकम् ।
चपलो रसकश्चेति ज्ञात्वाष्टौ सङ्ग्रहेद्रसान् ॥ 1.
पिनाकं नागमण्डूकं वज्रमित्यभ्रकं मतम् ।
श्वेतादिवर्णभेदेन प्रत्येकं तच्चतुर्व्विधम् ॥ 5
श्वेतं रक्तञ्च पीतञ्च कृष्णमेवं चतुर्व्विधम् ॥ 10.
सुखनिर्मोचपत्रञ्च तदभ्रं शस्तमीरितम् ॥ 12.
सचन्द्रिकञ्च किट्टाभं व्योम न ग्रासयेद्रसम् ।
ग्रसितश्च नियोज्योऽसौ लोहे चैव रसायने ॥ 13.
निश्चन्द्रिकं मृतं व्योम सेव्यं सर्व्वगदेषु च ।
सेवितं चन्द्रसंयुक्तं मेहं मन्दानलं चरेत् ॥ 14.
प्रतप्तं सप्तवाराणि निक्षिप्तं काञ्जिकेऽभ्रकम् ।
निर्दोषं जायते नूनं प्रक्षिप्तं वापि गोजले ।
त्रिफलाक्वथिते चापि गवां दुग्धे विशेषतः ॥ 17-18
चूर्णाभ्रं शालिसंयुक्तं वस्त्रबद्धं हि काञ्जिके ।
निर्यातं मर्द्दनाद्वस्त्राद्धान्याभ्रमिति कथ्यते ॥ 23.
धान्याभ्रं कासमर्द्दस्य रसेन परिमर्द्दितम् ।
पुटितं दशवारेण म्रियते नात्र संशयः ॥ 24.

अथ वैक्रान्तः—

अष्टास्रश्चाष्टफलकः षट्कोणो मसृणो गुरुः ।
शुद्धमिश्रितवर्णैश्च युक्तो वैक्रान्त उच्यते ॥
श्वेतो रक्तश्च पीतश्च नीलः पारावतच्छविः ।
श्यामलः कृष्णवर्णश्च कर्वुरश्चाष्टधा हि सः ॥ 55-56.

आयुःप्रदश्च बलवर्णकरोऽतिवृष्यः
प्रज्ञाप्रदः सकलदोषगदापहारी ।

दोषाग्निहृत् पविसमानगुणास्तदस्तौ
वैक्रान्तकाः खलु वपुर्बललोहकारी ॥
रसायनेषु सर्व्वेषु पूर्व्वगण्यः प्रतापवान् ।
वज्रस्थाने नियोक्तव्यो वैक्रान्तः सर्व्वदोषहा ॥ 57-58.
* * वैक्रान्तं वज्राकारं महारसम् ।
विन्ध्यस्य दक्षिणे वाऽस्ति ह्युत्तरे वाऽस्ति सर्व्वतः ।
विक्रामयति लोहानि तेन वैक्रान्तकः स्मृतः ॥ 60-61.
वैक्रान्तकाः स्युस्त्रिदिनं विशुद्धाः
संस्वेदिताः क्षारपटूनि दत्त्वा ।
अम्लेषु मूत्रेषु कुलत्थरम्भा-
नीरेऽथवा कोद्रववारिपक्काः ॥
कुलत्थक्वाथसंस्विन्नो वैक्रान्तः परिशुध्यति ।
म्रियतेऽष्टपुटैर्गन्धनिम्बुकद्रवसंयुतः ॥ 67-66.
भस्मीभूतन्तु वैक्रान्तं वज्रस्थाने नियोजयेत् ॥
मोचमोरटपालाशक्षारगोमूत्रभावितम् ।
वज्रकन्दनिशाकल्कफलचूर्णसमन्वितम् ।
तत्कल्कं टङ्कणं लाक्षाचूर्णं वैक्रान्तसम्भवम् ॥ 70-71.
नवसारसमायुक्तं मेषशृङ्गीद्रवान्वितम् ।
पिण्डितं मूकमूषस्थं ध्मापितञ्च हठाग्निना ॥ 72
तन्नैव पतते सत्त्वं वैक्रान्तस्य न संशयः ॥ 73.

अथ माक्षिकम्—

सुवर्णशैलप्रभवो विष्णुना काञ्चनो रसः ।
तापी[1] किरातचीनेषु यवनेषु च निर्म्मितः ॥ 77.
माक्षिकं द्विविध हेममाक्षिकन्तारमाक्षिकम् ।
तत्राद्यं माक्षिकं कान्यकुब्जोत्थं स्वर्णसन्निभम् ॥ 80

(1) तापी, a variant in the Poona ed, which also agrees with B and K

पाषाणवद्‌घनः प्रोक्तस्ताराख्योऽल्पगुणात्मकः ॥ 81.
मातुलुङ्गाम्बुगन्धाभ्यां पिष्टं मूषोदरे स्थितम् ।
पञ्चक्रोडपुटैर्दग्धं म्रियते माक्षिकं खलु ॥ 84.
क्षौद्रगन्धर्वतैलाभ्यां गोमूत्रेण घृतेन च ।
कदलीकन्दसारेण भावितं माक्षिकं मुहुः ।
मूषायां मुञ्चति ध्मातं सत्त्वं शुल्बनिभं मृदु ॥[1] 89-90.

अथ विमलः—

विमलस्त्रिविधः प्रोक्तो हेमाद्यस्तारपूर्वकः ।
तृतीयः कांस्यविमलस्तत्तत्कान्त्या स लक्ष्यते ॥ 96.
वर्त्तुलः कोणसंयुक्तः स्निग्धश्च फलकान्वितः ॥ 97.
गन्धाश्मलकुचाम्लैश्च म्रियते दशभिः पुटैः ॥ 100
सटङ्कलकुचद्रावैर्मेषशृङ्ग्याश्च भस्मना ।
पिष्ट्वा मूषोदरे लिप्तः संशोष्य च निरुध्य च ॥
षट्प्रस्थकोकिलैर्ध्मातो विमलः सीससन्निभः[2] ।
सत्त्वं मुञ्चति तद्युक्तो रसः स्यात्म रसायनः ॥ 101-102.
विमलं शिग्रुतोयेन काञ्चीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥
मोचकक्षारसंयुक्तं ध्मापितं मूकमूषगम् ।
सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥ 103-104.

अथ शिलाधातुः—

शिलाधातुर्द्विधा प्रोक्तो गोमूत्राद्यो रसायनः ।
कर्पूरपूर्वकश्चान्यस्तत्राद्यो द्विविधः पुनः ॥ 109

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(1) Verses 89 90 as also 103-104 occur both in Rasárnava and Rr by Nag. ; the Poona ed. reads पतते नात्र संशयः in the place of प्रयच्छति न संशयः ।

(2) Both the B. and K. Mss read सीससन्निभः । The Poona ed gives a variant शीतसन्निभः ।

ग्रीष्मे तीव्रार्कतप्तेभ्यः पादेभ्यो हिमभूभृतः ।
स्वर्णरूप्यार्कगर्भेभ्यः शिलाधातुर्विनिःसरेत् ॥ 110-111

अथ सस्यकम्—
मयूरकण्ठसच्छायं भाराढ्यमतिशस्यते ॥ 127.

मयूरतुल्यम्—

रसायनं वमनकरं गरघ्नं
श्वित्रापहं गदितमत्र मयूरतुल्यम् ॥ 129

लकुचद्रावगन्धाश्मटङ्कणेन समन्वितम् ।
निरुध्य मूषिकामध्ये ध्मायते कोष्ठैः पुटैः ॥ 132.
सस्यकस्य तु चूर्णन्तु पादसौभाग्यसंयुतम् ।
करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ॥
मध्यमन्धमूषायां ध्मापयेत्कोकिलत्रयम् ।
इन्द्रगोपाकृति चैव सत्त्वं भवति शोभनम् ॥ 133-134.
निम्बुद्रवाल्पटङ्काभ्यां मूषामध्ये निरुध्य च ।
ताम्ररूपं परिध्मातं सत्त्वं मुञ्चति सस्यकम् ॥ 135.
शुद्धं सस्यं शिखिकान्त[2] पूर्व्वसेचनसंयुतम् ।
नानाविधानयोगेन सत्त्वं मुञ्चति निश्चितम् ॥ 136.

अथ चपलः—
गौरः श्वेतोऽरुणः कृष्णश्चपलस्तु चतुर्विधः ।
हेमाभश्चैव ताराभो विशेषाद्रसबन्धनः ॥ 143.

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(1) The Poona ed. reads [illegible]. We have adopted the reading of Rasárnava.

(2) [illegible], another reading in the Poona ed., which also agrees with B. E. and Rasarnava.

(3) The Poona ed. reads [illegible]

शेषौ तु मध्यौ लाक्षावच्छीघ्रद्रावौ तु निष्फलौ।
वङ्गवद्द्रवते वह्नौ चपलस्तेन कीर्त्तितः ॥[1] 144.
चपलः स्फटिकच्छायः षड्स्रः[2] स्निग्धको गुरुः ॥ 146

अथ रसकः—

रसको द्विविधः प्रोक्तो दुर्दुरः कारवेल्लकः।
सदलो दुर्दुरः प्रोक्तो निर्दलः कारवेल्लकः ॥ 149.
खर्परः परिसन्तप्तः सप्तवारं निमज्जितः।
बीजपूररसस्यान्तर्निर्मलत्वं समश्नुते ॥
नृमूत्रे वाश्वमूत्रे वा तक्रे वा काञ्जिकेऽथवा।
प्रताप्य मज्जितं सम्यक् खर्परं परिशुध्यति ॥ 154-155
हरिद्रात्रिफलारालसिन्धुधूमैः सटङ्कणैः।
सारुष्करैश्च पादांशैः साम्लैः सम्मर्द्य खर्परम् ॥
लिप्तं वृन्ताकमूषायां शोषयित्वा निरुध्य च।
मूषां मूषोपरि[3] न्यस्य खर्परं प्रधमेत्ततः ॥
खर्परे प्रहृते ज्वाला भवेन्नीला सिता यदि।
तदा सन्दंशतो मूषां धृत्वा कृत्वा त्वधोमुखीम्।
शनैरास्फालयेद्भूमौ यथा नालं न भज्यते ॥
वङ्गाभं पतितं सत्त्वं समादाय नियोजयेत् ॥ 157-161
लाक्षागुडासुरीपथ्याहरिद्रासर्जटङ्कणैः।
सम्यक्सञ्चूर्ण्य तत्पक्वं गोदुग्धेन घृतेन च।
वृन्ताकमूषिकामध्ये निरुध्य गुटिकाकृति।
ध्मात्वा ध्मात्वा समाकृष्य ढालयित्वा शिलातले।
सत्त्वं वङ्गाकृति ग्राह्यं रसकस्य मनोहरम् ॥ 163-164.

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(1) Slokas 143 and 144 are from Rasárnava

(2) षड्स्र, another reading in the Poona ed, which we have adopted Slokas 143-146 are evidently borrowed with slight modifications from Rasarnava, VII. 26 27

(3) मूषां मूषोपरि, a variant in the Poona ed, which also agrees with B and K

यद्वा जलयुतां स्थालीं निखनेत्कोष्ठिकोदरे।
सच्छिद्रं तन्मुखे मल्लं तन्मुखेऽधोमुखं[1] क्षिपेत्।
मूषोपरि शिखितांश्च प्रक्षिप्य प्रधमेद्दृढम्।
पतितं स्थालिकानीरे सत्त्वमादाय योजयेत्॥ 165-166.
तत्सत्त्वं तालकोपेतं प्रक्षिप्य खलु खर्परे।
मर्द्दयेल्लोहदण्डेन भस्मीभवति निश्चितम्॥ 167-168.

अथ तृतीयोऽध्यायः।

अथोपरसाः साधारणरसाश्च।

अथ गन्धकः—

गन्धाश्मगैरिकाशीसकाक्षीतालशिलाञ्जनम्।
कङ्कुष्ठञ्चेत्युपरसाश्चाष्टौ पारदकर्म्मणि॥ 1.
स चापि त्रिविधो देवि शुकचञ्चुनिभो वरः।
मध्यमः पीतवर्णः स्याच्छुक्लवर्णोऽधमः प्रिये॥ 12
चतुर्धा गन्धको ज्ञेयो वर्णैः श्वेतादिभिः खलु।
*   *   *   *   *   *
दुर्लभः कृष्णवर्णश्च स जरामृत्युनाशनः॥ 13-15
गन्धको द्रावितो भृङ्गरसे क्षिप्तो विशुध्यति॥ 23
स्थाल्यां दुग्धं विनिक्षिप्य मुखे वस्त्रं निरुध्य च।
गन्धकं तत्र निक्षिप्य चूर्णितं सिकताकृति।
छादयेत्पृथुदीर्घेण खर्परेणैव गन्धकम्॥
ज्वालयेत्खर्परस्योर्द्ध्वं वनच्छागैस्तथोपलैः।
दुग्धे निपतितो गन्धो गलितः परिशुध्यति॥ 24-25.

(1) तन्मुखेऽधोमुखं, a variant in the Poona ed , which we have adopted

अथ गैरिकम्—

पाषाणगैरिकञ्चैकं द्वितीयं स्वर्णगैरिकम्।
पाषाणगैरिकं प्रोक्तं कठिनं ताम्रवर्णकम् ॥ 46
गैरिकन्तु गवां दुग्धैर्भावितं शुद्धिमृच्छति ॥ 49.

अथ कासीसम्—

कासीसं वालुकाद्येकं पुष्पपूर्व्वमथापरम्। 51.
तुवरीसत्त्ववत्सत्त्वमेतस्यापि समाहरेत् ॥ 54

अथ तुवरी—

सौराष्ट्रश्मनि सम्भूता[1] मृत्स्ना सा तुवरी मता।
वस्त्रेषु लिप्यते यासौ मञ्जिष्ठारागवर्द्धिनी ॥
* * फुल्लिका चेति द्वितीया परिकीर्त्तिता।
ईषत्पीता गुरुस्निग्धा * * *
निर्भारा शुभ्रवर्णा च स्निग्धा साम्लापरा मता।
सा फुल्लतुवरी प्रोक्ता लेपात् ताम्रं चरेदयः ॥ 59-62.

काङ्क्षी काषाया कटुकाम्लकण्ठ्या
केश्या व्रणघ्नी विषनाशनी च।
श्वित्रापहा नेत्रहिता त्रिदोष-
शान्तिप्रदा पारदजारणी च ॥ 63.

तुवरी काञ्जिके क्षिप्ता त्रिदिनाच्छुद्धिमृच्छति।
क्षाराम्लैर्मर्दिता ध्माता सत्त्वं मुञ्चति निश्चितम् ॥ 64.
गोपित्तेन शत वारान् सौराष्ट्रीं भावयेत् ततः।
धमित्वा पातयेत् सत्त्वं क्रामणं चातिगुह्यकम् ॥ 65.

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(1) सौराष्ट्रमृत्सनि, a variant in the Poona ed , which also agrees with B and K.

अथ तालकम्—

हरितालं द्विधा प्रोक्तं पत्राख्यं[1] पिण्डसंज्ञकम् ।
स्वर्णवर्णं गुरु स्निग्धं तनुपत्रं च भासुरम् ॥ 66
स्विन्नं कुष्माण्डतोये वा तिलक्षारजलेऽपि वा ।
तोये वा चूर्णसंयुक्ते दोलायन्त्रेण शुध्यति ॥ 69.
मधुतुल्ये घनीभूते कषाये ब्रह्ममूलजे ।
त्रिवारं तालकं भाव्यं पिष्ट्वा मूत्रेऽथ माहिषे ॥
उपलैर्दशभिर्देयं पुटं कृत्वाथ पेषयेत् ।
एवं द्वादशधा पाच्यं शुद्धं योगेषु योजयेत् ॥ 74-75
पलालकं रवेर्दुग्धैर्दिनमेकं विमर्दयेत् ।
क्षिप्त्वा षोडशिकातैले मिश्रयित्वा ततः पचेत् ॥
अनावृतप्रदेशे च सप्तयामावधि ध्रुवम् ।
स्वाङ्गशीतमधःस्थं च सत्त्वं श्वेतं समाहरेत् ॥ 80-81

अथ मनःशिला—

अष्टमांशेन किट्टेन गुडगुग्गुलुसर्पिषा ।
कोष्ठ्यां कृत्वा दृढं ध्मात्वा सत्त्वं मुञ्चेन्मनःशिला ॥ 95.

अथाञ्जनानि—

सौवीरमञ्जनं प्रोक्तं रसाञ्जनमतः परम् ।
स्रोतोऽञ्जनं तदन्यच्च पुष्पाञ्जनकमेव च ॥
नीलाञ्जनं च तेषां हि स्वरूपमिह वर्ण्यते ।
सौवीरमञ्जनं धूम्रं रक्तपित्तहरं हिमम् ॥ 98-99
अञ्जनानि विशुध्यन्ति भृङ्गराजनिजद्रवैः ।
मनोह्वासत्त्ववत् सत्त्वमञ्जनानां समाहरेत् ॥
वल्मीकशिखराकारं भङ्गे नीलोत्पलद्युति ।
घृष्टं तु गैरिकच्छायं स्रोतोजं लक्षयेद्बुधः ॥

(1) The Poona ed. reads पत्रान्' and K. reads पत्राख्यं', which we have adopted.

गोशकृद्रसमूत्रेषु घृतक्षौद्रवसासु च।
भावितं बहुशस्तच्च शीघ्रं बध्नाति सूतकम् ॥ 105-107.

अथ कङ्कुष्ठम्—

हिमवत्पादशिखरे कङ्कुष्ठमुपजायते। 109.
केचिद्वदन्ति कङ्कुष्ठं सद्योजातस्य दन्तिनः। 111
वदन्ति श्वेतपीताभं तदतीवविरेचनम्। 112.

अथ साधारणरसाः—

कम्पिल्लश्च परो गौरीपाषाणो नवसारकः।
कपर्दो वह्निजारश्च गिरिसिन्दूरहिङ्गुली ॥
मृद्दारशृङ्गमित्यष्टौ साधारणरसाः स्मृताः।
रससिद्धिकराः प्रोक्ता नागार्ज्जुनपुरःसरैः ॥ 120-121.

अथ कम्पिल्लः—

इष्टिकाचूर्णसङ्काशश्चन्द्रिकाढ्योऽतिरेचनः।
सौराष्ट्रदेशे चोत्पन्नः स हि कम्पिल्लकः स्मृतः ॥ 122.

अथ गौरीपाषाणः—

स्फटिकाभश्च शङ्खाभो हरिद्राभस्त्रयः स्मृताः।
तालवद्दारयेत् सत्त्वं शुद्धं शुभ्रं प्रयोजयेत् ॥ 124-126

अथ नवसारः—

करीरपीलुकाष्ठेषु पच्यमानेषु चोद्भवः।
क्षारोऽसौ नवसारः स्याच्चुलिकालवणाभिधः ॥
इष्टिकादहने जातं पाण्डुरं लवणं लघु।
तदुक्तं नवसाराख्यं चूलिकालवणं च तत्।
रसेन्द्रजारणं लोहद्रावणं जठराग्निकृत् ॥
गुल्मप्लीहास्यशोषघ्नं भुक्तमांसादिजारणम्। 127-129.

अथ वराटकाः—

पीताभा ग्रन्थिका पृष्ठे दीर्घवृत्ता वराटिका।
रसवैद्यैर्विनिर्दिष्टा सा चराचरसंज्ञिका ॥ 130.
वराटाः काञ्जिके स्विन्ना यामाच्छुद्धिमवाप्नुयुः ॥ 134.

अथाग्निजारः—

समुद्रेणाग्निनक्रस्य जरायुर्वहिरुज्झितः।
संशुष्को भानुतापेन सोऽग्निजार इति स्मृतः ॥ 135

अथ गिरिसिन्दूरम्—

महागिरिषु चाल्पायःपाषाणान्तःस्थितो रसः 137.

अथ हिङ्गुलः—

एतस्मादाहृतः सूतो जीर्णगन्धसमो गुणैः ॥ 141.
दरदः पातनायन्त्रे पातितश्च जलाश्रये।
तत्सत्त्वं सूतसङ्काशं पातयेन्नात्र संशयः ॥ 144

अथ मृद्दारशृङ्गकम्—

सदलं पीतवर्णं च भवेद्गुर्जरमण्डले।
अर्वुदस्य गिरेः पार्श्वे जातं मृद्दारशृङ्गकम् ॥
सीससत्त्वं गुरु श्लेष्मघ्नमर्णं पंगदापहम्।
रसबन्धनमुत्कृष्टं केशरञ्जनमुत्तमम् ॥
साधारणरसाः सर्वे मातुलुङ्गार्द्रकाम्बुना।
त्रिरात्रं भाविताः शुष्का भवेयुर्दोषवर्जिताः ॥ 145-147.

अथ राजावर्त्तः—

राजावर्त्तोऽल्परक्तोरुनीलिमिमिश्रितप्रभः[1] । 149.
लुङ्गाम्बुगन्धकोपेतो राजावर्त्तो विचूर्णितः।
पुटनात्सप्तवारेण राजावर्त्तो मृतो भवेत् ॥ 153.

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(1) नीलिमामिश्रितप्रभः, another reading in the Poona ed , which agrees with B and K., but it is grammatically inaccurate.

अथ चतुर्थोऽध्यायः ।

अथ रत्नानि ।

अथ मणयः—

मणयोऽपि च विज्ञेयाः सूतबन्धस्य कारकाः ।
वैक्रान्तः सूर्यकान्तश्च हीरकं मौक्तिकं मणिः ॥
चन्द्रकान्तस्तथा चैव राजावर्त्तश्च सप्तमः ।
गरुडोद्गारकश्चैव ज्ञातव्या मणयस्त्वमी ॥
पुष्परागं महानीलं पद्मरागं प्रवालकम् ।
वैदूर्य्यं च तथा नीलमेते च मणयो मताः ॥ 1-3

अथ वज्रम्—

वज्रं च त्रिविधं प्रोक्तं नरो नारी नपुंसकम् ।
पूर्व्वं पूर्व्वमिह श्रेष्ठं रसवीर्य्यविपाकतः ॥ 26
अष्टास्रं चाष्टफलकं षट्कोणमतिभासुरम् ।
अम्बुदेन्द्रधनुर्वारितरं पुंवज्रमुच्यते ॥ 27.
तदेव चिपिटाकारं स्त्रीवज्रं वर्त्तुलायतम् ।
वर्त्तुलं कुण्ठकोणाग्रं किञ्चिद्गुरु नपुंसकम् ॥ 28.
श्वेतादिवर्णभेदेन तदेकैकं चतुर्विधम् ।
ब्रह्मक्षत्रियविट्शूद्रं स्वस्ववर्णफलप्रदम् ॥ 30.

आयुःप्रदं झटिति सद्गुणदं च वृष्यं
दोषत्रयप्रशमनं सकलामयघ्नम् ।
सूतेन्द्रबन्धवधसद्गुणकृत् प्रदीपं
मृत्युञ्जयं तदमृतोपममेव वज्रम् ॥ 32.

कुलत्थक्वाथके स्विन्नं कोद्रवक्वथितेन वा ।
एकयामावधि स्विन्नं वज्रं शुध्यति निश्चितम् ॥

वज्रं मत्कुणरक्तेन चतुर्वारं विभावितम् ।
सुगन्धिमूषिकामांसैर्वेष्टितैः परिवेष्ट्य च[1] ॥
पुटेत् पुटैर्वराहाख्यैस्त्रिंशद्वारं ततः परम् ।
ध्मात्वा ध्मात्वा शतं वारान् कुलत्थक्वाथके क्षिपेत् ॥
अर्थ्यैरुक्तः शतं वारान् कर्त्तव्योऽयं विधिक्रमः ॥ 34-37.
कुलत्थक्वाथसंयुक्तलकुचद्रवपिष्टया ।
शिलया लिप्तमूषायां वज्रं क्षिप्त्वा निरुध्य च ।
अष्टवारं पुटेत् सम्यग्विशुष्कैश्च वनोपलैः ।
शतवारं ततो ध्मात्वा निक्षिप्तं शुद्धपारदे ।
निश्चितं म्रियते वज्रं भस्म वारितरं भवेत् ॥ 38-39.
सत्यवाक् सोमसेनानीरेतद्वज्रस्य मारणम् ।
दृष्टप्रत्ययसंयुक्तमुक्तवान् रसकौतुकी ॥ 40.
विलिप्तं मत्कुणस्यास्रे सप्तवारं विशोषितम् ॥
कासमर्दरसापूर्णे लोहपात्रे निवेशितम् ।
सप्तवारं परिध्मातं वज्रभस्म भवेत् खलु ॥
ब्रह्मज्योतिर्मुनीन्द्रेण क्रमोऽयं परिकीर्त्तितः । 41-43.
मदनस्य फलोद्भूतरसेन चौणिनागकैः ।
क्षतकल्केन संलिप्य पुटेद्विंशतिवारकम् ॥
वज्रचर्णं भवेद्वर्य्यं योजयेच्च रसादिषु ॥ 44-45

अथ रत्नभस्मक्रमः—

लकुचद्रावसंपिष्टैः शिलागन्धकतालकैः ।
वज्रं विनान्यरत्नानि म्रियन्तेऽष्टपुटैः खलु ॥ 63
रामठं पञ्चलवणं क्षाराणां त्रितयं तथा ।
मांसद्राव्याम्लवेतस्[2] चूलिकालवणं तथा ॥

(1) परिस्रवं च, another reading in the Poona ed , which does not agree with B and K.

(2) मांसद्राव्याम्लवेतस, a variant in the Poona ed , which we have adopted and which also agrees with B and K.

स्थूलं कुम्भीफलं पक्वं तथा ज्वालामुखी शुभा।
द्रवन्ती च रुदन्ती च पयस्या चित्रमूलकम्॥
दुग्धं स्नुह्यास्तथार्कस्य सर्व्वं संमर्द्य यत्नतः।
गोलं विधाय तन्मध्ये प्रक्षिपेत् तदनन्तरम्॥
गुणवन्नवरत्नानि जातिमन्ति शुभानि च।
भूर्जे तं गोलकं कृत्वा सूत्रेणावेष्ट्य यत्नतः॥
पुनर्वस्त्रेण संवेष्ट्य दोलायन्त्रे निधाय च।
सर्व्वाम्लयुक्तसन्धानपरिपूर्णघटोदरे॥
अहोरात्रत्रयं यावत् स्वेदयेत्तीव्रवह्निना।
तस्मादाहृत्य सङ्क्षाल्य रत्नजां द्रुतिमाहरेत्॥ 64-69.
मुक्ताचूर्णन्तु सप्ताहं वेतसाम्लेन मर्द्दितम्।
जम्बीरोदरमध्ये तु धान्यराशौ विनिक्षिपेत्॥
सप्ताहादुद्धृतश्चैव पुटे दत्त्वा द्रुतिं हरेत्[1]। 70-71.
वज्रवल्ल्यन्तरस्थञ्च कृत्वा वज्रं निरोधयेत्।
अम्लभाण्डगतं स्वेद्यं सप्ताहाद्द्रवतां व्रजेत्॥ 72

अथ वैक्रान्तम्—

श्वेतवर्णन्तु वैक्रान्तमम्लवेतसभावितम्।
सप्ताहान्नात्र सन्देहः खरघर्म्मे द्रवत्यलम्॥ 73.
केतकीस्वरसो ग्राह्यः सैन्धवं स्वर्णपुष्पिका।
इन्द्रगोपकसंयुक्तं सर्व्वं भाण्डे विनिक्षिपेत्॥
सप्ताहं स्वेदयेदस्मिन् वैक्रान्तं द्रवतां व्रजेत्। 74-75.

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(1) द्रुतिं हरेत्, a variant in the Poona ed., which we have adopted.

अथो पञ्चमोऽध्यायः ।

अथ लोहानि ।

अथ हेमगुणाः—

शुद्धं लोहं कनकरजतं भानुलोहाश्मसारं
पूतीलोहं द्वितयमुदितं नागवङ्गाभिधानम् ।
मिश्रं लोहं त्रितयमुदितं पित्तलं कांस्यवर्त्तं
धातुर्लोहे लुह इति मतः सोऽप्यनेकार्थवाची[1] ॥ 1

प्राकृतं सहजं वह्निसम्भूतं खनिसम्भवम् ।
रसेन्द्रवेधसञ्जातं स्वर्णं पञ्चविधं स्मृतम् ॥ 2

सौख्यं वीर्य्यं बलं हन्ति रोगवर्गं करोति च ।
अशुद्धं न मृतं स्वर्णं तस्माच्छुद्धं समाचरेत् ॥ 11.

सुवर्णपत्रं तनु कर्षमानं[2]
शरावरुद्धं पटुधातुयुक्तम् ।
अङ्गारसंस्थं प्रहरार्द्धमानं
ध्मानेन तत् स्यात्तनु पूर्णवर्णम्[3] ॥ 12

लोहानां मारणं श्रेष्ठं सर्व्वेषां रसभस्मना ।
मूलीभिर्मध्यमं प्राहुः कनिष्ठं गन्धकादिभिः ॥ 13.

अरिलोहेन लोहस्य मारणं दुर्गुणप्रदम् ।
कृत्वा कण्टकवेध्यानि स्वर्णपत्राणि लेपयेत् ।
लुङ्गाम्बुभस्मसूतेन म्रियते दशभिः पुटैः ॥ 14

द्रुते विनिक्षिपेत् स्वर्णे लोहमानं मृतं रसम् ।
विचूर्ण्य लुङ्गतोयेन दरदेन समन्वितम् ॥

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(1) सोऽप्यनेकार्थवाची, a variant in the Poona ed, which we have adopted

(2) सुवर्णपत्र तनु कर्षमानं, another reading in the Poona ed, which we have accepted

(3) पूर्णवर्णम्, a different reading in the Poona ed, which we have retained

जायते कुङ्कुमच्छायं स्वर्णं द्वादशभिः पुटैः ॥ 15-16.
हेम्नः पादं मृतं सूत पिष्टमम्लेन केनचित् ।
पत्रे लिप्ता पुटैः पाच्यं दशभि[1]र्म्रियते ध्रुवम् ॥ 17.

अथ रजतम्—

सहजं खनिसञ्जातं कृत्रिमं च त्रिधा[2] मतम् ॥ 22.
नागेन टङ्कणेनैव वापितं शुद्धिमृच्छति ।
खर्परे भस्मचर्णाभ्यां परितः पालिकां चरेत् ॥
तत्र रूप्यं विनिक्षिप्य समसीससमन्वितम् ।
जातसीसक्षयं यावद्धमेत् तावत् पुनः पुनः ॥
इत्थं संशोधितं रूप्यं योजनीयं रसादिषु । 32-34
लकुचद्रवसूताभ्यां तारपत्रं प्रलेपयेत् ॥
ऊर्ध्वाधो गन्धकं दत्त्वा मूषामध्ये निरुध्य च ।
स्वेदयेद्वालुकायन्त्रे दिनमेकं दृढाग्निना ॥
स्वाङ्गशीतां च तां पिष्टिं साम्लतालेन मर्द्दिताम् ।
पुटेद्द्वादशवाराणि भस्मीभवति रूप्यकम् ॥ 35-37
माक्षीकचूर्णलुङ्गाम्लमर्द्दितं पुटितं शनैः ।
त्रिंशद्वारेण तत् तारं भस्मसाज्जायतेतराम् ॥ 38
तारपत्रं चतुर्भागं भागैकं शुद्धतालकम् ।
मर्द्य[3] जम्बीरजद्रावैस्तारपत्राणि लेपयेत् ॥
शोषयेदन्धयन्त्रे च त्रिंशदुपलकैः पचेत् ।
चतुर्दशपुटैरेवं निरुत्थं जायते ध्रुवम् ॥ 40-41.

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(1) पुटैः पाच्यं दशभि., a variant in the Poona ed, which we have adopted

(2) च त्रिधा, another reading in the Poona ed, which also agrees with B. and K.

(3) The Poona ed reads मर्द्यं, which is grammatically inaccurate.

अथ ताम्रम्—

म्लेच्छं नेपालकं चेति तयोर्नेपालमुत्तमम्।
नेपालादन्यखन्युत्थं म्लेच्छमित्यभिधीयते ॥ 44
जम्बीररसमंपिष्टरसगन्धकलेपितम्।
शुल्वपत्रं शरावस्थं त्रिपुटैर्याति पञ्चताम् ॥ 55.

अथायः

मुण्डं तीक्ष्णं च कान्तं च त्रिप्रकारमयः स्मृतम्।

अथ मुण्डम्—

मृदु कुण्ठं कडारं च त्रिविधं मुण्डमुच्यते ॥ 70.
द्रुतद्रावमविस्फोटं चिक्कणं मृदु तच्छुभम्।
हतं यन्प्रसरेद्दुःखात् तत्कुण्ठं मध्यमं स्मृतम् ॥
यद्धतं भज्यते भङ्गे कृष्णं स्यात्तत्कडारकम् ॥ 71-72

अथ तीक्ष्णम्—

* * * षड्विधं तीक्ष्णमुच्यते ॥ 75.
पक्वं घोणरोन्मुक्तं भङ्गे पारदवच्छवि।
नमने भङ्गुरं यत् तत् खरलोहमुदाहृतम् ॥ 76
वेगभङ्गरधारं[1] यत् सारलोहं तदीरितम् 78.

अथ कान्तम्—

भ्रामकं चुम्बकं चैव कर्षकं द्रावकं तथा।
एवं चतुर्विधं कान्तं रोमकान्तं च पञ्चमम् ॥
एकद्वित्रिचतुःपञ्चसर्वतोमुखमेव तत्।
पीतं कृष्णं तथा रक्तं त्रिवर्णं स्यात् पृथक् पृथक् ॥ 84-85
भ्रामयेल्लोहजातं तु तत् कान्तं भ्रामकं मतम् ॥
चुम्बयेच्चुम्बकं कान्तं कर्षयेत् कर्षकं तथा।
साक्षाद्यद्द्रावयेल्लोहं तत् कान्तं द्रावकं भवेत् ॥

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(1) The Poona ed reads वेगभङ्गुरधारम्, which is grammatically inaccurate

तद्रोमकान्तं स्फुटिताद्यतो रोमोद्गमो भवेत्। 88-89
मदोन्मत्तगजः सूतः कान्तसङ्गमुच्यते॥

    चैवं ज्ञात्वा ग्रहीतव्यं तत्प्रयत्नेन धीमता।
    मारुतातपनिक्षिप्तं वर्जयेन्नात्र संशयः॥ 92-93

पात्रे यस्य प्रसरति जले तैलबिन्दुर्न लिप्तं
गन्धं हिङ्गु त्यजति च तथा तिक्ततां निम्बकल्कः।
पाके दुग्धं भवति शिखराकारकं नैति भूमिं
कान्तं लोहं तदिदमुदितं लक्षणोक्तं न चान्यत्॥ 94.

    रीतितं घृतसंयुक्तं क्षिप्त्वायः खर्परे पचेत्।
    चालयेल्लोहदण्डेन यावत् क्षिप्तं द्रवं दहेत्॥
    पिष्ट्वा पिष्ट्वा पचेदेवं पञ्चवारमतः परम्।
    धात्रीफलरसैर्यद्वा त्रिफलाक्वथितोदकैः।
    पुटेल्लोहं चतुर्वारं भवेद्वारितरं खलु॥ 104-105

तीक्ष्णलोहस्य पत्राणि निर्दलानि दृढेऽनले।
ध्मात्वा क्षिपेज्जले सद्यः पाषाणोलूखलोदरे॥
खण्डयेद्गाढनिर्घातैः स्थूलया लोहपारया।
तन्मध्यात् स्थूलखण्डानि कृत्वा मल्लद्वयान्तरे॥
ध्मात्वा क्षिप्त्वा जले सम्यक् पूर्ववत् कण्डयेत् खलु।
तच्चूर्णं सूतगन्धाभ्यां पुटेद्विंशतिवारकम्॥

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(1) Cf. यत्पात्रे न प्रसरति जले तैलबिन्दुः प्रतप्ते
हिङ्गुर्गन्धं त्यजति च निजं तिक्ततां निम्बकल्कः।
तप्तं दुग्धं भवति शिखराकारकं नैति भूमिं
कृष्णाङ्गं स्यात् सजलचणकं कान्तलोहं तदुक्तम्॥
भावप्रकाशे कान्तलोहप्रकरणम्।

(2) A variant in the Poon1 ed wrich agrees with the भावप्रकाश, as quoted in the foet rote.

(3) [illegible], a reading in the Poona ed which also agrees with B. and K.

पुटे पुटे विधातव्यं पेषणं दृढवत्तरम्।
एवं भस्मीकृतं लोहं तत्तद्रोगेषु योजयेत्॥ 107-110
जम्बीरैरारनालैर्वा विंशत्यंशेन हिङ्गुलम्॥
पिष्ट्वा रुद्ध्वा पचेल्लोहं तद्द्रवैः पाचयेत् पुनः।
चत्वारिंशत्पुटैरेवं कान्तं तीक्ष्णं च मुण्डकम्॥
म्रियते नात्र सन्देहो दत्त्वा दत्त्वैव हिङ्गुलम्। 113-115
शुद्धसूतं द्विधा गन्धं खल्ले तु कृतकज्जलीम्।
द्वयोः समं लोहचूर्णं मर्दयेत् कन्यकाद्रवैः॥
यामद्वयात् समुद्धृत्य तद्गोलं ताम्रपात्रके।[1]
आच्छाद्यैरण्डपत्रैश्च यामार्द्धेऽत्युष्णता भवेत्॥
धान्यराशौ न्यसेत् पश्चात् त्रिदिनान्ते समुद्धरेत्।
संपेष्य गालयेद्वस्त्रे सत्त्वं वारितरं भवेत्॥
कान्तं तीक्ष्णं च मुण्डं च निरुत्थं जायते ध्रुवम्।
स्वर्णादीन् मारयेदेवं चूर्णं कृत्वा च लोहवत्॥ 134-137.
लोहकिट्टं सुसन्तप्तं यावज्जीर्य्यति तत् स्वयम्।
तच्चूर्णं जायते पेष्यं मण्डूरोऽयं प्रयोज्यते॥ 147
ये गुणा मारिते मुण्डे ते गुणा मुण्डकिट्टके।
तस्मात् सर्वत्र मण्डूरं रोगशान्त्यै प्रयोजयेत्। 148.

अथ वङ्गम्—

खुरकं मिश्रकं चेति द्विविधं वङ्गमुच्यते।
खुरं तत्र गुणैः श्रेष्ठं मिश्रकं न हितं मतम्॥ 153
धवलं मृदुलं स्निग्धं द्रुतद्रावं सगौरवम्।
निःशब्दं खुरवङ्गं स्यान्मिश्रकं श्यामशुभ्रकम्॥ 154
वङ्गं तिक्तोष्णकं रूक्षमीषद्वातप्रकोपनम्।
मेहश्लेष्मामयघ्नं च मेदोघ्नं क्रिमिनाशनम्॥ 155.

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(1) ताम्रपात्रके, a reading in the Poona ed., which also agrees with B. and K

द्रावयित्वा निशायुक्ते क्षिप्तं निर्गुण्डिकारसे ।
विशुध्यति त्रिवारेण खुरवङ्गं न संशयः ॥ 156.
सतालेनार्कदुग्धेन लिप्ता वङ्गदलान्यथ ।[1]
बोधिचिञ्चात्वचः क्षारैर्दद्याल्लघुपुटानि च ॥
मर्दयित्वा चरेद्भस्म * * * ॥ 159-160,

अथ सीसकम्—

द्रुतद्रावं महाभारं छेदे कृष्णसमुज्ज्वलम् ।
पूतिगन्धं बहिःकृष्णं शुद्धं सीसमतोऽन्यथा ॥ 171.
पलविंशतिकं नागमधस्तीव्रानलं क्षिपेत् ।
द्रुते नागे क्षिपेत् सूतं शुद्धं कर्षमितं शुभम् ॥
विघट्य निक्षिपेत् क्षारमेकैकं हि पलं पलम् ।
अर्जुनस्याश्वत्थस्य महाराजगिरेरपि ।
दाड़िमस्य मयरस्य चिञ्चा क्षारं पृथक् पृथक् ॥
एवं विंशतिरात्राणि पचेत् तीव्रेण वह्निना ।
विघट्टयन् दृढं दोर्भ्यां लोहदर्व्या प्रयत्नतः ॥
रक्तं तज्जायते भस्म कपोतच्छायमेव वा । 176-179.
शिलया रविदुग्धेन नागपत्राणि लेपयेत् ॥
मारयेत् पुटयोगेन निरुत्थं जायते तथा । 184-185.

अथ पित्तलम्—

रीतिका काकतुण्डी च द्विविधं पित्तलं भवेत् ।
सन्तप्ता काञ्जिके क्षिप्ता ताम्राभा रीतिका मता ॥
एवं या जायते कृष्णा काकतुण्डीति सा मता ॥ 192-193
गुर्वी मृद्वी च पीताभा साराङ्गी ताड़नक्षमा ।
सुस्निग्धा मसृणाङ्गी च रीतिरेतादृशी शुभा ॥ 195.
पूतिगन्धा तथा लघ्वी रीतिर्नेष्टा रसादिषु ॥ 196.

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(1) व्यथ, a variant in the Poona ed , which also agrees with B and K

निम्बूरसशिलागन्धवेष्टिता पुटिताष्टधा ।
रीतिरायाति भस्मत्वं ततो योज्या यथायथम् ॥
ताम्रवन्मारणं तस्याः कृत्वा सर्व्वत्र योजयेत् । 201-202.

अथ कांस्यम्—

अष्टभागेन ताम्रेण द्विभागकुटिलेन च ।
विद्रुतेन भवेत् कांस्यं * * * ॥ 205
म्रियते गन्धतालाभ्यां निरुत्थं पञ्चभिः पुटैः ॥ 210

अथ वर्त्तलोहम्—

कांस्यार्करीतिलोहाहिजातं तद्वर्त्तलोहकम् ।
तदेव पञ्चलोहाख्यं लोहविद्भिरुदाहृतम् ॥ 212
म्रियते गन्धतालाभ्यां पुटितं वर्त्तलोहकम् । 216

अथ षष्ठोऽध्यायः ।

अथ शिष्योपनयनम् ।

आचार्य्यो ज्ञानवान् दक्षो रसशास्त्रविशारदः ।
मन्त्रसिद्धो महावीरो निश्चलः शिववत्सलः ॥
देवीभक्तः सदाधीरो देवतायागतत्परः ।
सर्वाम्नायविशेषज्ञः कुशलो रसकर्म्मणि ॥
एवं लक्षणसंयुक्तो रसविद्यागुरुर्भवेत् ।
गुरुभक्ताः सदाचाराः सत्यवन्तो दृढ़व्रताः ॥
निरालस्याः स्वधर्मज्ञाः सदाज्ञापरिपालकाः ।
दम्भमात्सर्य्यनिर्मुक्ताः कुलाचारेषु दीक्षिताः ॥
अत्यन्तसाधकाः शान्ता मन्त्राराधनतत्पराः ।
इत्येवं लक्षणैर्युक्ताः शिष्याः स्युः कार्य्यसिद्धये ॥ 3-7.

आतङ्करहिते देशे धर्मराज्ये मनोरमे।
उमामहेश्वरोपेते समृद्ध नगरे शुभे॥
कर्त्तव्यं साधनं तत्र रसराजस्य धीमता।
अत्यन्तोपवने रम्ये चतुर्द्वारोपशोभिते॥
तत्र शाला प्रकर्त्तव्या सुविस्तीर्णा मनोरमा।
सम्यग्वातायनोपेता दिव्यचित्रैर्विचित्रिता॥ 13-15
निष्कत्रयं हेमपत्रं रसेन्द्र नवनिष्ककम्।
अम्लेन मर्दयेद्यामं तेन लिङ्गं तु कारयेत्॥
तल्लिङ्गं पूजयेत् तत्र सुशुभैरुपचारकैः॥
लिङ्गकोटिसहस्रस्य यत् फलं सम्यगर्चनात्।
तत् फलं कोटिगुणितं रसलिङ्गार्चनाद्भवेत्॥
ब्रह्महत्यासहस्राणि स्त्रीगोहत्यायुतानि[1] च।
तत्क्षणाद्विलयं यान्ति रसलिङ्गस्य दर्शनात्॥ 19-22
रसविद्या[2] शिवेनोक्ता दातव्या साधकाय वै।
यथोक्तेन विधानेन गुरुणा मुदितात्मना॥ 30.
कोष्ठी मूषा वङ्कनाली तुषाङ्गारवनोपलाः॥
भस्त्रिका दण्डिकानेकाः शिलाखल्लान्युलूखलम्।

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अनेन मूलमन्त्रेण भैरवं तत्र पूजयेत्।
सर्व्वेषां रससिद्धानां नाम सङ्कीर्त्तयेत्तदा॥

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सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः।
वन्द्याः पूज्याः प्रयत्नेन ततः कुर्य्याद्रसार्चनम्॥ 52-61
हर्षयेद्विजदेवानां तर्पयेदिष्टदेवताः।
कुमारीयोगिनीयोगीश्वरान् म्लेच्छकसाधकान्[3]॥ 62.

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(1) स्त्रीगोहत्यायुतानि च, a variant in the Poona ed , which we have adopted
(2) B and K. reads रसदीक्षा।
(3) म्लेच्छकसाधकान्, a variant in the Poona ed , which also agrees with B.

रसविद्या दृढं गोप्या मातुर्गुह्यमिव ध्रुवम् ।
भवेद्वीर्यवती गुप्ता निर्वीर्या च प्रकाशनात् ॥ 70.

अथ सप्तमोऽध्यायः ।

अथ रसशाला ।

रसशालां प्रकुर्वीत सर्वबाधाविवर्जिताम् ।
सर्वौषधमये देशे रम्यकूपसमन्विते ॥
नानोपकरणोपेतां प्राकारेण सुशोभिताम् ॥
शालायाः पूर्वदिग्भागे स्थापयेद्रसभैरवम् ।
वह्निकर्माणि चाग्नेये याम्ये पाषाणकर्म च ॥
नैर्ऋत्ये शस्त्रकर्माणि वारुणे क्षालनादिकम् ।
शोषणं वायुकोणे च वेधकर्मोत्तरे तथा ॥
स्थापनं सिद्धवस्तूनां प्रकुर्यादीशकोणके ।
पदार्थसङ्ग्रहः कार्यो रससाधनहेतुकः ॥
सत्त्वपातनकोष्ठीश्च सुराकोष्ठीं सुशोभनाम् ।
भूमिकोष्ठीं चलत्कोष्ठीं जलद्रोणीरनेकशः ॥
भस्त्रिकायुगलं तद्वच्चलित्रे वंशलोहयोः ।

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करणानि विचित्राणि द्रव्याण्यपि समाहरेत् ।
कण्डनीं पेषणीं खल्लान् द्रोणीरूपांश्च वर्तुलान् ।
सूक्ष्मच्छिद्रमहत्स्राव्यां द्रव्यगालनहेतवे ।
चालनीश्च कटत्राणि * * * ॥

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(1) [illegible], a variant in the Poona ed., which we have adopted.

मूषामृत्सुवकार्यासवनोपलकपिष्टकम् ।
काचायोमृदुवराटानां कूपिकाचषकानि च । 1-18.
निर्लोभाः सत्यवक्तारो देवब्राह्मणपूजकाः ।
यमिनः पथ्यभोक्तारो योजनीया रसायने ॥ 30.
तत्तद्दोषधनामज्ञाः शुचयो वञ्चनोज्झिताः ।
नानाविषयभाषाज्ञास्ते मता भिषजाम्वृतौ ॥ 32.

अथ अष्टमोऽध्यायः ।

अथ परिभाषा ।

कथ्यते सोमदेवेन मुग्धवैद्यप्रवृत्तये ।
परिभाषा रसेन्द्रस्य शास्त्रैः सिद्धैश्च भाषिता ॥ 1.
अर्द्धं सिद्धरसस्य तैलघृतयोर्लोहस्य भागोऽष्टमः
संसिद्धाखिललोहचर्णवटकादीनां तथा सप्तमः ।
यो दीयेत भिषग्वराय गदिभिर्निर्दिश्य धन्वन्तरिं
सर्व्वारोग्यसुखाप्तये निगदितो भागः स धन्वन्तरेः ॥ 2.
धातुभिर्गन्धकाद्यैश्च निर्द्रवैर्मर्दितो रसः
सुश्लक्ष्णः कज्जलाभोऽसौ कज्जलीत्यभिधीयते ॥
सद्रवा मर्द्दिता सैव रसपङ्क इति स्मृतः ॥ 5-6.
मृतं तरति यत्तोये लोहं वारितरं हि तत् ।
अङ्गुष्ठतर्ज्जनीघृष्टं यत्तद्रेखान्तरं[1] विशेत् ॥
मृत लोहं तदुद्दिष्टं रेखापूर्णाभिधानतः ॥

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(1) रेखान्तरं, a variant in the Poona ed. which we have adopted

गुडगुञ्जासुखस्पर्शमध्वाज्यैः[1] सह योजितम्।
नायाति प्रकृतिं ध्मानादपुनर्भवमुच्यते॥
तस्योपरि गुरु द्रव्यं धान्यं चोपनयेद्ध्रुवम्।
हंसवत् तीर्य्यते वारिण्युत्तमं परिकीर्त्तितम्॥ 25-28.
रौप्येण सह संयुक्तं ध्मातं रौप्ये न चेल्लगेत्।
तदा निरुत्थमित्युक्तं लोहं तदपुनर्भवम्॥ 29.
तीक्ष्णा नीलाञ्जनोपेतं ध्मातं हि बहुशो दृढम्।
मृदुकृष्णं द्रुतद्राव वरनागं[3] तदुच्यते॥ 38.
मृतस्य पुनरुद्भूतिः सम्प्रोक्तोत्थापनाख्यया। 39.
इयन्मानस्य सूतस्य भोज्यद्रव्यात्मिका मतिः।
इयतीत्युच्यते ग्रासो ग्रासमानमितीरितम्॥ 64.
चतुःषष्ट्यंशतो बीजप्रक्षेपो मुखमुच्यते।
एवङ्कृते रसो ग्रासलोलुपो मुखवान् भवेत्॥
कठिनान्यपि लोहानि क्षमो भवति भक्षितुम्। 68-69.
लेपः क्षेपश्च कुन्तश्च धूमाख्यः शब्दसंज्ञकः।
लेपेन कुरुते लोहं स्वर्णं वा रजतं तथा॥ 80.
वह्नौ धूमायमानेऽन्तः प्रक्षिप्तरसधूमतः।
स्वर्णाद्यापादनं लोहे धूमवेधः स ईरितः॥ 83.
मुखस्थितरसेनाल्पलोहस्य धमनात् खलु।
स्वर्णरूप्यत्वजननं शब्दवेधः स कीर्त्तितः॥ 84.

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(1) Cf. द्रवमधुगुञ्जाटङ्क. समं लौहभस्म मर्दयेत् विचक्षणः।
धमेद्वह्नौ यदा पुनर्लौहभावं न गच्छेत् तदा योज्यं रसायने॥
लौहभावं यदा गच्छेत् तं पुनर्मारयेत् सुधीः।
रसचन्द्रिका मारणमारणाध्यायः।

(2) We have adopetd the reading in B and K. The Poona ed, however, reads रौप्ये च चेल्लगेत्, which, from the chemical point of view, is untenable.

(3) वरनागं, a variant in the Poona ed, which also agrees with B.

रसनिगममहाब्धेः सोमदेवः समन्तात्
स्फुटतरपरिभाषानामरत्नानि हृत्वा ।
व्यरचयदतियत्नात् तैरिमां कण्ठमालां
कलयतु[1] भिषगग्र्यो मण्डनार्थं सभायाम् ॥ 89.

अथ नवमोऽध्यायः ।

अथ यन्त्राणि ।

अथ यन्त्राणि वक्ष्यन्ते रसतन्त्राण्यशेषतः ।
समालोक्य समासेन सोमदेवेन साम्प्रतम् ॥ 1

अथ दोलायन्त्रम्—

द्रवद्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च ।
मुखमुभयतो द्वारद्वयं कृत्वा प्रयत्नतः ॥ 3.
तयोस्तु निक्षिपेद्दण्डं तन्मध्ये रसपोटलीम् ।
बद्ध्वा तु स्वेदयेदेतद्दोलायन्त्रमिति स्मृतम् ॥ 4.

अथ स्वेदनीयन्त्रम्—

साम्बुस्थालीमुखाबद्धे वस्त्रे पाक्यं निवेशयेत् ।
पिधाय पच्यते यत्र स्वेदनीयन्त्रमुच्यते ॥ 5.

अथ पातनायन्त्रम्—

अष्टाङ्गुलपरिणाहमानाढ्येन दशाङ्गुलम् ।
चतुरङ्गुलकोत्सेधं तोयाधारं गलादधः ॥

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(1) कलयतु, another reading in the Poona ed , which we have adopted

अधोभाण्डे मुखं तस्य भाण्डस्योपरिवर्त्तिनः
पोड़शाङ्गुलविस्तीर्णपृष्ठस्यास्ये प्रवेशयेत् ॥
पार्श्वयोर्मद्दिषीक्षीरचूर्णमण्डूरफाणितैः ।
लिप्ता विशोषयेत् सन्धिं जलाधारे जलं क्षिपेत् ।
चुल्लग्रामारोपयेदेतत् पातनायन्त्रमीरितम् ॥ 6-8.

अथाधःपातनायन्त्रम्—
अथोर्द्ध्वभाजने[1] लिप्तं स्थापितस्य जले सुधीः ।
दीप्तैर्वनोपलैः कुर्य्यादधःपातं प्रयत्नतः ॥ 9

अथ दीपिकायन्त्रम्—
कच्छपयन्त्रान्तर्गतमृन्मयपीठस्थदीपिकासंस्थः ।
यस्मिन्निपतति सूतः प्रोक्तं तद्दीपिकायन्त्रम् ॥ 10

अथ ढेकीयन्त्रम्—
भाण्डकण्ठादधश्छिद्रे वेणुनालं विनिक्षिपेत् ।
कांस्यपात्रद्वयं कृत्वा सम्पुटं जलगर्भितम् ॥
नलिकास्यं तत्र योज्य दृढं तत्रापि कारयेत् ।
युक्तद्रव्यैर्विनिक्षिप्तः पूर्व्वं तत्र घटे रसः ।
अग्निना तापितो नालात्तोये तस्मिन् पतत्यधः ॥
यावदुष्णं भवेत्सर्व्वं भाजनं तावदेव हि ।
जायते रससन्धानं ढेकीयन्त्रमितीरितम् ॥ 11-14

अथ वालुकायन्त्रम्—
सरसां गूढ़वक्त्रां मृद्वस्त्राङ्गुलघनावृताम् ।
शोषितां काचकलसीं पूरयेत् त्रिषु भागयोः ॥
भाण्डे वितस्तिगम्भीरे वालुका सुप्रतिष्ठिता ।
तद्भाण्डं पूरयेत् त्रिभिरन्याभिरवगुण्ठयेत् ॥

(1) K reads अथ, which we have retained.

भाण्डवक्त्रं माणिकया सन्धिं लिम्पेन्मृदा पचेत्।
चुल्ल्यां लवणस्य चादाहान्मणिकापृष्ठवर्त्तिनः॥
एतद्धि वालुकायन्त्रं तद्यन्त्रं लवणाश्रयम् ॥34-36.

अथ लवणयन्त्रम्—

एवं लवणनिक्षेपात् प्रोक्तं लवणयन्त्रकम्। 38

अथ नालिकायन्त्रम्—

लोहनालगतं सूतं भाण्डे लवणपूरिते।
निरुद्धं विपचेत् प्राग्वन्नालिकायन्त्रमीरितम् ॥ 41

अथ तिर्यक्पातनयन्त्रम्—

क्षिपेद्रसं घटे दीर्घनताधोनालसंयुते।[1]
तन्नालं निक्षिपेदन्यघटकुक्ष्यन्तरे खलु॥
तत्र रुद्ध्वा मृदा सम्यग्वदने घटयोरधः।
अधस्ताद्रसकुम्भस्य ज्वालयेत् तीव्रपावकम्॥
इतरस्मिन् घटे तोयं प्रक्षिपेत् स्वादुशीतलम्।
तिर्यक्पातनमेतद्धि वार्त्तिकैरभिधीयते ॥ 48-50.

अथ हिङ्गुलाकृष्टिविद्याधरयन्त्रम्—

स्थालिकोपरि विन्यस्य स्थालीं सम्यङ्निरुध्य च।
ऊर्ध्वस्थाल्यां जलं क्षिप्त्वा वह्निं प्रज्वालयेदधः॥
एतद्विद्याधरं यन्त्रं हिङ्गुलाकृष्टिहेतवे ॥ 57-58

अथ धूपयन्त्रम—

विधायाष्टाङ्गुलं पात्रं लौहमष्टाङ्गुलोच्छ्रयम्।
कण्ठाधो द्व्यङ्गुले देशे गलाधारे हि तत्र च॥
तिर्यग्लोहशलाकाश्च तन्वीस्तिर्यग्विनिक्षिपेत्।
तन्वि स्वर्णपत्राणि तासामुपरि विन्यसेत्॥

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(1) दीर्घनताधो, a variant in the Poona ed., which also agrees with B. and K.

पात्राधो निक्षिपेद्धूमं वक्ष्यमाणमिहैव हि
तत् पात्रं न्युब्जपात्रेण छादयेदपरेण हि ॥
मृदा विलिप्य सन्धिं च वह्निं प्रज्वालयेत् ।
तेन पत्राणि कृत्स्नानि[1] द्रुतान्युक्तविधानतः

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गन्धालकशिलानां हि कज्जल्या वा मृताहिना ॥
धूपनं स्वर्णपत्राणां प्रथमं परिकीर्त्तितम् ।
तारार्थं तारपत्राणि मृतवङ्गेन धूपयेत् ॥
धूपयेच्च यथायोग्यैरन्यैरुपरसैरपि ।
धूपयन्त्रमिदं प्रोक्तं जारणाद्रव्यसाधनम् ॥ 70-76.

अथ दशमोऽध्यायः ।

अथ मूषादिकथनम् ।

मृत्तिका पाण्डुरस्थूला शर्करा शोणपाण्डुरा ।
चिराध्मानसहा सा हि मूषार्थमतिशस्यते ॥
तदभावे हि वाल्मीकी कौलाली वा समीर्यते ॥

या मृत्तिका दग्धतुषैः शणेन
शिखित्रकैर्वा हयलद्दिना च ।
लोहेन दण्डेन च कुट्टिता सा
साधारणी स्यात् खलु मूषिकार्थम्[2] ॥ 5-6

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(1) कृत्स्नानि, another reading in the Poona ed., which we have accepted

(2) स्यात् and मूषिकार्थं' are two different readings in the Poona ed., which we have adopted.

अथ पुटानि—

लोहादेरपुनर्भावो गुणाधिक्यं ततोऽग्रता ।
अनप्सु मज्जनं रेखापूर्णता पुटतो भवेत् ॥ 51.
निम्ने विस्तरतः कुण्डे द्विहस्ते चतुरस्रके ।
वनोपलसहस्रेण पूरिते पुटनौषधम् ॥
कोष्ठयां[1] रुद्ध्वं प्रयत्नेन पिष्टिकोपरि निक्षिपेत् ।
वनोपलसहस्रार्द्धं कोष्ठिकोपरि विन्यसेत् ॥
वह्निं प्रज्वालयेत् तत्र महापुटमिदं स्मृतम् । 54-56.
सुवर्णं रजतं ताम्रं त्रपु सीसकमायसम् ।
षड़ेतानि च लोहानि कृत्रिमे कांस्यपित्तले ॥ 70.
लवणानि षड़्च्यन्ते सामुद्रं सैन्धवं विड़म् ।
सौवर्चलं रोमकं च चूलिकालवणं तथा ॥
क्षारत्रयं समाख्यातं यवसर्जिकटङ्कणम् ॥ 71.

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जम्बूकमण्डुकवसा वसा कच्छपसम्भवा ।
कर्कोटो शिशुमारो च गोमूत्ररनरेङ्गवा ।
अजोष्ट्रखरमेषाणां महिषस्य वसा तथा ॥ 76-77
मूत्राणि हस्तिकरभमहिषोखरवाजिनाम् ।
गोऽजावीनां स्त्रियः पुंसां पुष्पं वीजं तु योजयेत् ॥ 78.
चाङ्गेरीचणकाम्लं च अम्लिकं कोलदाड़िमम् ।
अम्लवेता तिन्तिड़ीकं च नारङ्गं रसपत्रिका ।
करवन्दं तथा चान्यदम्लवर्गः प्रकीर्त्तितः ॥
चणकाम्लश्च सर्व्वेषामेक एव प्रशस्यते ॥
अम्लवेतसमेकं वा सर्व्वेषामुत्तमोत्तमम् ।
रसादीनां विशुद्धयर्थं द्रावणे जारणे हितम् ॥

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(1) कोष्ठ्या, a variant in the Poona ed, which we have adopted.

कोलदाडिमवृक्षाम्लचुलिकाचुक्रिकारसम् ।
पञ्चाम्लकं समुद्दिष्टं तथोक्तं चाम्लपञ्चकम् ॥ 80-81.
स्फटिका गैरिका लोणं भस्म वल्मीकमृत्तिका ।
रसप्रयोगकुशलैः कीर्त्तिताः पञ्च मृत्तिकाः ॥ 85
शृङ्गिकं कालकूटं च वत्सनाभं सक्तुविषम् ।
पित्तं च विषवर्गोऽयं स वरः परिकीर्त्तितः ॥ 86
लाङ्गली विषमुष्टिश्च करवीरजटा तथा ।
नलिकः कनकोऽर्कश्च वर्गो ह्युपविषात्मकः ॥ 88
गुडगुग्गलुगुञ्जाज्यसारघटङ्कणान्वितैः ।
दुर्द्रावाग्निलोहादेर्द्रावणाय गणो मतः ॥ 100

अथैकादशोऽध्यायः ।

अथ रसशोधनादिकथनम् ।

रसार्णवादिशास्त्राणि निरीक्ष्य कथितं मया ।
रसोपयोगि यत्किञ्चिद्विज्ञातं तत्प्रदर्शितम् ।
अधुना रसराजस्य संस्कारान् सम्प्रचक्ष्महे ॥ 10.
विषं वह्निर्मलश्चेति दोषा नैसर्गिकास्त्रयः ।
यौगिकौ नागवङ्गौ द्वौ * * * ॥ 14-15.
तस्मात् सूतविधानार्थं सहायैर्निपुणैर्युतः ।
सर्वोपस्कारमादाय रसकर्म समाचरेत् ॥ 20.
द्वे सहस्रे पलानां तु सहस्रं शतमेव वा ।
अष्टाविंशत् पलान्येव दश पञ्चैकमेव वा ॥
पलार्द्धेनैव कर्त्तव्यः संस्कारः सूतकस्य च ।
सुदिने शुभनक्षत्रे रसशोधनमाचरेत ॥ 21-22.

रसस्तु पादांशसुवर्णजीर्णः
पिष्टीकृतो गन्धकयोगतश्च ।
तुल्यांशगन्धैः पुटितः क्रमेण
निर्बीजनामा सकलामयघ्नः ॥ 72.
पिष्टीकृतैरभ्रकसत्त्वहेम-
तारार्ककान्तैः परिजारितो यः ।
हतस्ततः षड्गुणगन्धकेन
स बीजबद्धो विपुलप्रभावः ॥ 73

काकोदुम्बरिकाया दुग्धेन सुभावितो हिङ्गुः ।
मर्दनपुटेन विधिना सूतं भस्मीकरोत्येव ॥ 111.
देवदालीं हरिक्रान्तामारनालेन पेषयेत् ।
तद्द्रवैः सप्तधा सूतं कुर्यान्मर्दितमूर्च्छितम् ॥
तत्सूतं खर्परे दद्याद्दत्त्वा दत्त्वा तु तद्द्रवम् ।
चुल्लुपरि पचेच्चाज्ञा भस्म स्याल्लवणोपमम् ॥ 112-113.
अपामार्गस्य बीजानि तथैरण्डस्य चर्णयेत् ।
तच्चर्णं पारदे देयं मूषायामधरोत्तरम् ॥
रुद्ध्वा लघुपुटैः पश्चाच्चतुर्भिर्भस्मतां नयेत् । 114-115.

Extracts from

RASARAJALAKSHMI.

विष्णुदेवविरचितायाः रसराजलक्ष्म्याः

प्रारम्भः —

यस्येच्छाङ्कुरवल्लरी मुकुलिता नानाकलाकौतुकैः
चातुर्य्यैकविलोलपल्लववतो कीर्त्तिप्रसूनप्रसूः ।
संनिर्वापयति ज्वरत्रयमहो छायाकलापैर्नृणां
सोऽयं पातु विचारमूर्त्तिरखिलं कालापलीढं जगत् ॥ 1

जयति दुरितसर्पस्तंडमंत्रोद्यदर्पः
प्रबलगदविनाशः सेविविध्वस्तनाशः ।
शिव इव विज(बीज ?)मंत्रः संहितायोगमंत्रः
त्रिपुरहरतनूजस्तेजसः कायपुंजः ॥ 2.

इति श्रीपण्डितमहादेवतनयश्रीविष्णुदेवविरचितायां
रसराजलक्ष्म्यामुल्लासः प्रथमः ॥

दृष्ट्वेमं रससागरं शिवकृतं श्रीकाकचण्डीश्वरो-
तन्त्रं सूतमहोदधिं रससुधाम्भोधिं भवानीमतम् ।
व्याड़िं सुश्रुतसूत्रमीशहृदयं स्वच्छंदशत्यागमं
श्रीदामोदरवासुदेवभगवद्‌गोविन्दनागार्जुनान् ॥

प्रथमः उल्लासः ।

स्वच्छंदशत्यागमसारभूतः
समुद्धृतो विष्णुभिषग्वरेण ॥ 110.

द्वितीयः उल्लासः ।

आलोक्य सुश्रुतं वृन्दहारीतचरकादिकान् ।
आत्रेयं वाग्भटं सिद्धसारं दामोदरं गुरुम् ॥

तृतीयः उल्लासः । *

Colophon at the end of the Rasarájalakshmí—

राजन् (सप्त) शार्वरिवत्सराद्यदिवसे वारे हिमांशोरिदं
चंचद्भूतलपत्तने विजयिनि श्रीबुक्कपृथ्वीपतेः ।
शास्त्रं वैद्यकसाररूपमकरोत् श्रीविष्णुदेवः कविः
वाग्देवीचरणारविंदमकरंदामोदसौरस्यवाक् ॥

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* Foll. 1—43. Line. 10. Rasarájalakshmis, de medicamentis metallorum et fossilium ope conficiendis liber, a Rámeśvara (bhatta), Vishnus filio, compositus Incipit आनंदैकरसे विकल्पकलनानिर्मुक्तबोधात्मकि मार्गंत्यावधिसंगतिव्यपगते etc. ॥ १ ॥ स्वमिसुखीमयननंथनेन (l. स्वमीसुखी०) sphurad Rasámbhodhi-gabhiragarbhat । śri-Vishnudevi (o devi) labhate prayatnát sri Vishnuvatsád Rasarájalakshmim ॥ 2 ॥ Drishtvemam Rasaságaram, Śivakritam śri-Karkachandeśvaritantram, Sútamahodadhim, Rasasudhambhodhim, Bhavánimatam, Vyadi[m], Suśrutasútram, Iśahridayam, Svachchhandaśaktyágamam, śri-Dámodara-Vásudeva-Bhagavad Govinda-Nágárjunán ॥3॥ आनंदमानंदकरं प्रसन्नं ज्ञानस्वरूपं निजभावयुक्तम् । योगींद्रमीड्यं भवरोगवैद्यं श्रीमद्गुरुं नित्यमहं नमामि ॥ ४ ॥

महारसाः स्युस्तमादावष्टौ पारदहिंगुले ।
वैक्रान्त सस्यकं शैल चपलं रसकीमलम् ॥ ५ ॥
अभ्रकं तुत्थक (tutthakam)कासं राजावर्तमथाञ्जनं ।
वज्रकैकान्तक (o vaikrantakam) चेति टंकणं च रसान्विदुः ॥६॥
तालकं गंधकश्चिलि चितिर्व्हेचरगेरिका: ।
इत्यादयोपरसाः पूर्वाचार्यैरुदोरिता. ॥ ७ ॥

Aufrecht's "Catalogus," p. 321, No. 761

Extracts from

RASANAKSHATRAMALIKA.

मथनसिंहविरचितायाः रसनक्षत्रमालिकायाः

उद्धृताः श्लोकाः ।

चतुश्चतुःशंखकपर्द्दिकानां
सतक्रजम्बीरविमर्द्दितानाम् ।
आफेनमाक्षीकविषद्वयानां
पलं पलं दन्तिफलान्वितानाम् ॥ 25

यतभस्मगन्धसूता त्रितयं वङ्गस्य शुद्धतीक्ष्णस्य ।
दग्धा मृगस्य शृङ्गं त्रिगुणं दत्वा रसार्द्धविषम् ॥ 123.
चित्रकशीतशिवाव्हषदश्मूलढिवनढविल्वगिरैः ।
कलहन्तारविज्ञतकैः प्रत्येकं भावनत्रितयम् ॥ 124
दत्वा सुसिद्धमात्रो मारिचधूपेन धूपितः सम्यक् ।
स्वच्छन्दभैरवाख्यो रसः समस्तामयध्वंसी ॥ 125.
त्रिकटुकरसेन युक्तो विशेषतः सन्निपातहरः ।
ग्रहणिगदामयशूलव्रणविद्रधिवातगुल्मजयी ॥ 126.
इति स्वच्छन्दभैरवो रसः ॥*

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* The स्वच्छन्दभैरव रस mentioned in the रसनक्षत्रमालिका is quite distinct from that, which is stated in the रसेन्द्रचिन्तामणि । Neither has it any analogy with what is described in the रसरत्नसमुच्चय ।

इयं मालविभूपालभिषजा भिषजां मता।
ज्ञाता मथनसिंहेन रसनक्षत्रमालिका ॥ 142.

इति रसनक्षत्रमालिका समाप्ता ॥ स्वस्ति
संवत् १५५७ आश्विन कृष्ण ५ सोमे।

Extracts from

RASARATNAKARA

नित्यनाथविरचितात् रसरत्नाकरात्

उद्धृताः श्लोकाः।

यदुक्तं शम्भुना पूर्व्वं रसखण्डे रसार्णवे।
रसस्य बन्दनार्थं च दीपिकारसमङ्गले॥
व्याधितानां हितार्थाय प्रोक्तं नागार्ज्जुनेन यत्।
उक्तं चर्पटिसिद्धेन[1] स्वर्गवैद्यकपालिके।
अनेकरसशास्त्रेषु संहितास्वागमेषु च।
यदुक्तं वाभटे तन्त्रे सुश्रुते वैद्यसागरे॥
अन्यैश्च बहुभिः सिद्धैः यदुक्तञ्च विलोक्य तत्।
तत्र यद्यदसाध्यं स्याद्यद्यद्दुर्लभमौषधम्॥
तत्तत् सर्व्वं परित्यज्य सारभूतं समुद्धृतम्॥
क्वचिच्छास्त्रे क्रिया नास्ति क्रमश्चापि न च क्वचित्।

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(1) चूर्णटिसिद्धेन is the reading in the Sanskrit college MS.

मात्रायुक्तिः क्वचिन्नास्ति सम्प्रदायो न च क्वचित् ।
तेन सिद्धिर्न तत्रास्ति रसे वाथ रसायने ॥
वैद्ये वादे प्रयोगे च तस्माद्यत्नो मया कृतः ॥
यद्यद्गुरुमुखाज्ज्ञातं स्वानुभूतञ्च यन्मया ।
तत्तल्लोकहितार्थाय प्रकटीक्रियतेऽधुना ॥

प्रथमोपदेशे ।

इति श्रीपार्व्वतीपुत्रनित्यनाथसिद्धविरचिते रसरत्नाकरे
रसखण्डे रसपीठिका नाम प्रथमोपदेशः ।

परीक्षा मारिते सूते कर्त्तव्या च यथोदिता ।
अधस्तुषाग्निना तप्तो ह्यक्षीणस्तिष्ठते यदा ।
तदा भस्म विजानीयाच्छुक्लगां यामं निरीक्षयेत् ॥

तृतीयोपदेशे ।

दन्ते शृङ्गेऽथवा वंशे रक्षयेत् साधितं रसम् ॥

चतुर्थोपदेशे ।

अथातः शुद्धसूतस्य मूर्च्छनाविधिरुच्यते ।
मेघनादावचाहिङ्गुपूरणैर्मर्दयेद्रसम् ॥
नष्टपिष्टन्तु तद्गोलं हिङ्गुना वेष्टयेद्बहिः ।
पचेल्लवणयन्त्रस्थं दिनैकं चण्डवह्निना ॥
उद्धृत्य समादाय दृढं वस्त्रेण बन्धयेत् ।
जम्बीरो गन्धकं तुल्यं दत्त्वा सोमानले पचेत् ॥
जीर्णे गन्धे पुनर्देयं षड्भिर्वारैः समं समम् ।
षड्गुणे गन्धके जीर्णे मूर्च्छितो रोगहा भवेत् ॥

चतुर्थोपदेशे ।

Extracts from

DHATURATNAMALA

धातुरत्नमालायाः

प्रारम्भः—

प्रणम्य विततीं शक्तिं त्रिसृष्ट्युत्पत्तिकारिणीं ।
धातूनां रत्नमालायामभिधायं करोम्यहं ॥ 1.
ब्रह्मविष्णुहराद्यान् ये मर्त्या ध्यायंति नित्यशः ।
ज्ञानदानप्रदानाय सा मे विश्वेश्वरी मता ॥ 2.

अथ धातूनां रत्नमालां वक्ष्यामि ।

रौप्यं हेमं तथा ताम्रं नागं वंगं तथायसं ।
खर्पराभ्रकमौक्तं च प्रवालं तालकं शिला ॥ 3.
सुवर्णमाक्षिकं सूतं हीरकं च ब्रवीम्यहं ।
सर्वधातूपधातूनां लक्षणं मारणं गुणं ॥ 4.

अथ रौप्यमारणं ।

रौप्यं शुद्धं समादाय नागेन शुद्ध शोधयेत् ।
शुद्धे तारे पुनः पश्चात् सूक्ष्मपत्राणि कारयेत् ॥ 5.
निंबचिंचिणिद्राक्षाभिः शोधयेच्च पृथक् पृथक् ।
क्षालयेदुदकैः सार्द्धं तथा दुग्धेन शोधयेत् ॥ 6
गंधपारदयोरैक्यं किंचिद्दंगं च घर्षयेत् ।
द्राक्षाया द्रवसंयुक्तं तारपत्राणि शोधयेत् ॥ 7.
चक्रयन्त्रे विनिक्षिप्य लेपयेद्वस्त्रमृत्तिकां ।
क्षिपेद्गजपुटे गर्त्ते ज्वालयेद्बहुछाणकान् ॥ 8.

समाप्तिः—

ग्रंथो वैद्यकनामायं रससिद्धांतसागरात् ।
धातूनां रत्नमाला च ततो वैद्यस्य हेतवे ॥ 176

मरणेभ्यो भयत्रस्ता रोगग्रस्ताश्च ये नराः।
रत्नमाला कृता तेषां वैद्यानां च हिताय वै ॥ 177
इति श्रीवैद्यकशास्त्रे अश्विनीकुमारसंहितायां
धातुरत्नमालायां समाप्तोऽयं ग्रंथः ॥

The following is taken from Aufrecht's "Catalogus" —No. 760.

Incipit :—प्रणम्य शारदां शक्तिं सृष्टेरुत्पत्तिकारकां। धातूनां रत्नमालां च विबोधाय करोम्यहं ॥ 1 ब्रह्माविष्णुहरान् ध्यायेन्नत्वा ध्यायंति नित्यशः। तेषां वरप्रदानाच्च मा मयैवमुदीर्यते ॥ 2 रूप्यं हेम तथा ताम्रं नागं वंगं तथायसं। खर्परं गगनं प्रोक्तं प्रवालं तालकं शिला ॥ 3 माक्षिकं गंधकं सूतं हीरकं च ब्रवीम्यहं। सर्वधातूपधातूना लक्षणं मारणं गणान् ॥ 4 रूप्यं शुद्धं समानीय नागमूषा नु शोधयेत्। शुद्धे तारे पुनः पश्चात् सूक्ष्मपत्राणि कारयेत् ॥ 5 निंबुचिंचिणोद्राक्षाभिः शोधनीयं पृथक् पृथक्। क्षालयेदुदकैः सार्द्धं तथा दुग्धेन शोधयेत् ॥ 6 गंधकं पारदं रूप्यं किंचिद्वंगं च घर्षयेत्। द्राक्षारसेन संयुक्तं तारपत्राणि लेपयेत् ॥ 7 नक्तं यन्त्रे विनिक्षिप्य लेपयेद्वस्त्रमृत्तिकां। क्षेप्यं गजपुटे गर्त्ते ज्वालयेच्च शतोपलैः ॥ 8.

In fine libelli disticha haec leguntur.

ग्रंथो वैद्य[क]नामायं Rasasiddhantasāgarāt।
धातूनां रत्नमाला च कृता वैद्यसुहितवे ॥ 1
मरणेभ्यो भयत्रस्ता रोगग्रस्ताश्च ये नराः।
रत्नमाला हि धातूना कृता तेषा हिताय वै ॥ 2.
Jatya Gurjarakhandas cha, Devadatto hi dharmavit।
Harer nāmābhidhānasya सुतस्तस्य भिषग्वरः ॥ 3.
सहितारसकर्माणि यस्य बुद्धिर्गरीयसी।
तेन शास्त्रविधिज्ञेन कृता रत्नस्य मालिका ॥ 4.
इति देवदत्तकृतवैद्यकशास्त्रे धातुरत्नमाला ॥

Extracts from

RASAPRADIPA

रसप्रदीपादुद्धृताः श्लोकाः ।

A—MS. from Allahabad.
B—MS. from Benares.

अथ शङ्खद्रावरसः ।

स्फटिका[1] नवसारश्च सुश्वेता[2] च सुवर्च्चिका ।
पृथक् दशपलोन्मानं गन्धकः पिचुसंमितः[3] ॥
चूर्णयित्वा क्षिपेद्भाण्डे मृन्मये मृद्विलेपिते[4] ।
तन्मुखं मुद्रयेत् सम्यक् मृद्भाण्डेनापरेण च ॥
सरन्ध्रोदरकेणैव चुल्ल्यां तिर्य्यक् च धारयेत् ।
अधः प्रज्वालयेद्वह्निं हठाद्यावद्रसः स्रवेत् ॥
माषैकं सेवयेद्यत्नात्[5] दन्तस्पर्शविवर्जितम् ।
गुल्मोदरयकृत्प्लीहग्रन्थियक्ष्मादिशूलनुत् ॥
बलपुष्टिप्रदो ह्येष भुक्तं च जारयेत् क्षणात् ।
विलोक्यतां महालोका रसमाहात्म्यमद्भुतम् ।
कपर्दकाश्च लोहानां यस्मिन् क्षिप्ता[6] गलन्ति हि ॥

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(1) A reads स्फाटिका, B reads स्फुटिका ।
(2) B reads सुसेता, which is not correct.
(3) B reads पिचसिचुत, which is not correct.
(4) मृत्ति॰ लेपिते is the reading in B
(5) B reads यत्नु ।
(6) A reads क्षिप्ता ।

फिरङ्गव्याधि :—

गैरिकं रसकर्पूरम् चपला च पृथक् पृथक्।
टङ्कमात्रं विनिष्पिष्य[1] तावन्तोदलजैः रसैः॥
वत्यश्चतुर्द्दशास्तेषां[2] कर्त्तव्या भिषगुत्तमैः[3]।
सायं प्रातः समश्नीयात्[4] एकैका दिनसप्तकम्[5]॥
सद्दता योल्लिका[6] देया भोजनार्थं निरन्तरम्।
फिरङ्गव्याधिनाशाय वटिकेयमनुत्तमा॥ *

(1) A reads विनि ष्पिष्य।

(2) A reads चतुर्दशस्तेषां, B reads चतुर्दशस्तेषां।

(3) B reads भिषगोत्तमैः, which is incorrect

(4) B reads समश्नीयात्, which is incorrect

(5) दिनसप्तक, an incorrect variant in B

(6) गोधूमगोटिका इत्यर्थः।

* The following is taken from योगतरङ्गिणी of Trimallabhatta printed in Bombay in the Saka year 1810

यंत्रे सुसिद्धे रसगन्धकाख्यं
निधाय युक्त्या पलानि पंच।
कर्षोन्मितं तालमनःशिलाख्यं
सतुत्थकान्तं तुवरीयुतानाम्॥ ६० ॥
समं धवाना समभागिकाना
चूर्णीकृत चोपरितो निदध्यात्।
पक्वेन दत्वा मरिचीमयेन
दिष्ट्वा दलीनस्य शरावमेकम्॥ ६१ ॥
ससक्रमंताल निधाय यत्र-
माच्छादयेत् खर्परकं विमधि।
चूर्णप्रलिप्तोदरमूर्ध्वभाग
संस्थाप्य सम्यग् दृढ मुद्रणाम्॥ ६२ ॥
प्रज्वालयेदग्निमधः प्रसीय
संस्थाप्य यत्रोपरि वस्त्रमार्द्रम्।
वह्निं प्रदद्याद्दिनषट्कमेव
तत् स्वाङ्गशीतं परिगृह्य युक्त्या ॥६३॥

चन्द्रोदयाख्यरसवर्णने—

कासे श्वासे फिरङ्गाख्ये रोगे च परमो हितः।

अथ उपायान्तरम्—

सुगन्ध्या[1] कुलञ्जञ्चैव[2] पारसीकयमानिका।
भल्लातकफलं चापि पलमानं पृथक् पृथक्॥
पलार्द्धमानः सूतः स्यात् षट्पलोऽत्र गुड़ः स्मृतः।
एकीकृत्याखिलं कुर्य्यात् वटीः कर्षप्रमाणतः॥
खादेदेकां वटीं प्रातर्यावदारोग्यदर्शनम्।
गोदुग्धस्यानुपानेन फिरङ्गामयनाशिनी[3]॥
निम्बुकेन[4] विना नैव वर्जनीयमिहापरम्॥

अथ उपायान्तरम्—

चोपचीनीभवं चूर्णं शाणमानं समाक्षिकम्॥
फिरङ्गव्याधिनाशाय भक्षयेल्लवणं त्यजेत्॥

तं द्रोणपुष्पीपयसा प्रपिष्टं
कृष्या विदध्यान्नवसादरं च।
कर्षप्रमानं प्रहरत्रयं च
वह्निं प्रदद्यादथ शीतलाङ्गीम्॥ ६४॥
निष्कास्य कूपी सिकताख्यर्यंवा-
दाकृष्य कंठस्थमसुं प्रगृह्यात्।
कर्पूरनामा रसनायकोऽयं
वल्लं पुराणेन गुडेन भुक्तः॥ ६५॥
निर्वातभाजा मनुजा च पथ्य-
शीलेन कुष्ठामयनाशनं स्यात्॥
फिरङ्गकरिकेशरी सकलकुष्ठकालानलो-
ऽखिलव्रणविनाशकृद्व्रणजगत्संपूर्त्तिप्रदः।
सुवर्णसमवर्णकृद्दलहुताशनैजस्कर
समस्तगदतस्करो रसपतिः स कर्पूरकः॥ ६६॥

इति कर्पूररस श्रीघ्रसव्वं स्यात्।

(1) B reads सुगन्ध्या।
(2) B reads कलकं चैव।
(3) B reads फिरङ्गापविनाशिनी।
(4) B reads निंबुकेन।

Extracts from

DHATUKRIYA
or
DHATUMANJARI

रुद्रयामले धातुक्रिया धातुमञ्जरी वा ।*

श्रीगणेशाय नमः ।

पार्व्वत्युवाच ।

अथानन्तरं[1] देवेश ब्रूहि धातुसुसंस्कृतिम्[2] ।
येन विज्ञानमात्रेण साधयेद्धातुमंज्ञितः ॥ 1

महादेव उवाच ।

धातुस्त्र्यविधः प्रोक्तः तुर्य्यस्तुर्य्ये स्वयन्ततः (?)[3] ।
सत्त्वं रजस्तमश्चैव चतुर्थस्तु निरामयः ॥ 2
राजसे राजसो सिद्धिस्तामसे तामसो सदा ।
सत्त्वसाधनं सात्त्विकश्चे आप्नोति[4] सर्व्वसाधनम् ॥ 3.

पार्व्वत्युवाच ।

कथ्यतां देवदेवेश सत्त्वं राजसतामसम् ।
अतीव गुणवत्[5] धातोः कार्य्यं लक्षणलक्षितम्[6] ॥ 4

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* The Ulwar MS (A) reads धातुक्रिया, a part of the Rudrayámala, but the Benares MS. (B) reads धातुमञ्जरी, a part of the same. The two MSS. are exactly the same in subject matter, differing only in name.

(1) A reads अथानन्तर, which is grammatically incorrect.

(2) A reads धातव्य संस्कृति, which is grossly incorrect.

(3) The sense here is not clear

(4) A reads आप्नोति, which seems to be incorrect

(5) A has गुणवती, which appears to be incorrect.

(6) कार्या लक्षणलक्षिता., a variant in A, which is not correct.

उपधातुक्रमेणैव तेषां लक्षणसाधनम् ।
विटकौ च मुदा युक्ता तेषां कर्म्मसु[1] साधनम् ॥ 5
उपकारो[2] गुणलक्षं नाना कार्य्यक्रिया शुभा ।
वियोगयोगचाञ्चल्यं वर्णभेदैस्तु मारणम् ॥ 6.
समग्रं देवदेवेश विशेषा धातुकृत्क्रियाः ।
येन विज्ञानमात्रेण साधयेत् गन्धकौः क्रियाः ॥ 7.

महादेव उवाच ।
पृथिव्या गर्भमध्ये तु अनेका धातुस्तिष्ठति[3] ।
विस्तृता[4] कियत्कालेन धातुर्नानाविधोदिता[5] ॥ 8
गुणलक्षणसंयुक्तां[6] साम्प्रतं न स्मरामि ह[7] ॥
कथं ते कथयिष्यामि[8] वद ब्रह्माण्डवासिनि ॥ 9.

पार्व्वत्युवाच ।
ये केचित् स्मर्य्यन्त[9] ईश व्यक्तं कथय साम्प्रतम् ।
भवतो[10]ऽनुग्रहेणैव साधनार्थश्च[11] सिध्यति ॥ 10

महादेव उवाच ।
शृणु देवि प्रवक्ष्यामि धातुं नानाविधस्थितिम् ।
गुणलक्षणसंयुक्तां यथा बुद्धिः[12] कथिष्यति ॥ 11.

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(1) A reads erroneously कर्संस्व ।

(2) A reads उपकार, which is grammatically incorrect

(3) अनेका धातु तिष्ठति, a variant in A, which treats the word धातु in the masculine as well as in the feminine genders

(4) A reads विस्तृता, which is not correct

(5) धातुनानाविधोदिता, an incorrect variant in A

(6) A reads संयुक्ता, which is grammatically incorrect

(7) A reads स्मरति ह, which is incorrect.

(8) कथयामास is the incorrect reading in A

(9) A and B read स्मरते, which is grammatically incorrect.

(10) भवता is the reading in A and B, which is not correct

(11) साधनासर्थ्व is the incorrect reading in A and B

(12) A and B read बुद्धया ।

मुख्यप्राधान्यता[1] एते रङ्गलोहकताम्रकैः[2] ।
रजतेनैव[3] संयुक्ता धातोरुत्तमता सदा ॥ 12.
मध्यमा सत्त्वजा धातुः[4] नीचा च त्रपुसीसयोः ।
संयोगे धातुनामा हि नीचा नीचतरा स्मृता ॥ 13.
संयोगान्ते त्रिधा प्रोक्ता उत्तमा मध्यमाधमा ।
ताम्रजासत्वयोर्योगे[5] नारीधातुः प्रजायते ॥ 14.
एषा[6] मध्योत्तमा प्रोक्ता कार्य्यकारणयोगके ।
त्रपुताम्रसंयोगेन[7] जाता धातुश्च मध्यमा ॥ 15
सीसके[8] भङ्गदा प्रोक्ता कार्य्यकाले सदोदिता ।
अनेनैव प्रकारेण येन येन च कर्म्मसु ॥ 16.
कर्त्तव्या जाधवी विद्या ज्ञात्वा[9] बुद्धिविशारदैः ।
अभङ्गं सीसके जातं शुद्ध उत्पत्यकारकम् ॥ 17
हाटके श्वेतता जातेः[10] अचया[11] रजते यदि ।
लघुद्रावः शुभे शुल्वे लोहे च द्राविणी कला ॥ 18.
जासत्वे अङ्गहीना च काठिन्याभ्यधिकौ परौ ।
कला एताश्च धातूनां जातिर्भवति शुद्धता[12] ॥ 19.
कला एतादृशी दिव्याः प्राप्तः[13] सिद्धस्तु जायते ।

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(1) मुख्यप्रधानता is the correct reading प्राधान्यता is grammatically incorrcet.
(2) A and B have रङ्गलोहताम्रकै, which mars the metre
(3) A reads रजतेनैव, which is not correct
(4) धातु' is used here in the feminine gender both by A and B
(5) Vide verse 20.
(6) Both A and B read एतत, which is grammatically incorrect
(7) संयोगे is the reading in A and B, which mars the metre
(8) A and B reads शोणके ।
(9) A reads ज्ञात्वा, which is incorrect
(10) A and B read जाते, which is incorrect
(11) A reads अचयो । B reads अचमो । Both the readings seem to be incorrect
(12) जाते भवति शुद्धिता', a variant in A जाते भवति रश्मिवा, an incorrect variant in B
(13) A and B read प्राप्ते, which is grammatically incorrect.

शुल्वजासत्वसंयोगे नारीधातुस्तु[1] जायते ॥ 20
कार्य्यानेककरी प्रोक्ता पाकामोदसु[2]कोमला ।
मारणी जारणी दिव्या चारणी त्रोटने तथा ॥ 21
निर्गन्धा वर्णरहिता जातिभेदकरी स्मृता[3] ।
एतावद्[4]गुणसंयुक्ता कार्य्यकारणसंयुता ॥ 22
संस्कारैः संस्कृता सर्व्वैः[5] सर्व्वसिद्धिकरी स्मृता ।
नानासुवर्णकार्य्येषु रूप्यकार्य्येषु संयुता ॥ 23
धातुधौता च या[6] धातुः सुधामायःसुसंस्कृता ।
कार्य्यसिद्धिकरी[7] श्रेष्ठा ज्येष्ठकार्य्यविधायिका[8] ॥ 24
सर्व्वथाशु सुधामायः[9] ग्रासग्रहणग्राहकः(?) ।
ग्राहयेत् ग्रासमात्रेण पाचयेदशनं[10] स्वियम् ॥ 25.
स्वकीयाशनसंपर्क[11] जाते भवति सिद्धिदा ।
अन्यथा नैव सिध्यन्ति जायते मृग-अस्रुवत् ॥ 26.
तस्मात्तेनैव यत्नेन सुधामायः[12]सुसंस्कृतिः ।
यथोक्तसंस्कृतियुता[13] सर्व्वतो धातुरुत्तमा[14] ॥ 27
क्रियोचितसुसंस्कारान्[15] कारयेद्युयत्नतः सदा ।

(1) A reads नारीधन्यत्तसु। B reads नारीधन्यवस्तु । Both seem to be incorrect. (Vide verse 14)

(2) B reads पाकामोदस्तु, which is unintelligible.

(3) A reads मता ।

(4) Both A and B read एतद्, which destroys the metre

(5) A and B want सर्व्वैः, thus rendering the foot incomplete

(6) A and B read चै, which is not correct.

(7) कार्यसिद्धिकरा is the variant in A and B.

(8) A and B read विधायका, which is grammatically incorrect.

(9) A has an incomplete foot सर्वतेशधा , B also has सर्वतिशुधा ।

(10) A reads पाचयेत् शन , B reads पाचयेत् शनं । Both of them seem to be incorrect

(11) B reads संयुक्त ।

(12) A reads सुधाधाय । B reads शुधाधाय । Both are unintelligible.

(13) Both A and B read संयुक्ता, which mars the metre.

(14) सर्वे ते धातुरुत्तमा., a variant in A and B, which is grammatically incorrect

(15) A and B read only संस्काराः, which is incorrect.

यथोदितैस्तु संस्कारैर्युक्ता कार्य्यकरी सदा ॥ 28.
सर्व्वलक्षणसंयुक्ता धातुर्ग्रीता सदैव हि ।
जायते नैव सन्देहः कार्य्यकारणकारिका[1] ॥ 29.

पार्व्वत्युवाच ।
कियत्परिमिता धातुः संख्या वदतु मे विभो ।
उत्पत्तिर्लक्षणं तेषां स्थानं चैव[2] पृथक् पृथक् ॥ 30
कथ्यतां देवदेवेश लक्ष्यलक्षणसंस्कृतिः ।
भेदोऽभेदोऽथ[3] योगश्च मारणं चारणं तथा ॥ 31.
पातं द्रावणं चैव त्रोटनं जारणं तथा ।
सारणं जीवनं षण्ढं गोपनं लेपनं पुनः[4] ॥ 32.
जातिभेदः सुगन्धश्च मेलनं जरणं परम् ।
समग्रं कथ्यतां देव उपधातुकरी क्रिया ॥ 33.

महादेव उवाच ।
शृणु देवि प्रवक्ष्यामि धातुस्थानानि लक्षणम् ।
उपधातुरनेका हि[5] तेषां मारणचारणम् ॥ 34.
अक्षयं राग(?)[6]कारं च शोधनं बन्धनं तथा ।
मारणादि च यत् प्रोक्तं तत् सर्व्वं श्रूयतां शुभे[7] ॥ 35.

पार्व्वत्युवाच ।
प्रथमं वद देवेश धात्वनुक्रमलक्षणम् ।
प्रत्येकस्थानरूपं हि गुणसम्बन्धकारकम् ॥ 36

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(1) Both A and B read कारका, which seems to be incorrect.

(2) B reads स्थानं तेषा ।

(3) भेदाभेदाय is the incorrect reading in A and B.

(4) A reads गुतः, which is senseless

(5) उपधातुरनेकानि, an incorrect variant in A and B.

(6) Both A and B want this word, which may be supposed to be राग or बल here.

(7) तत् सर्वं कथयामि ते, a variant in A

महादेव उवाच ।

शृणु देवि प्रयत्नेन सिद्धान्तवचनं मम ।
येन विज्ञानमात्रेण जायते धातुकृत्क्रिया ॥ 37.
प्रथमे धातुनामानि संक्षेपात् कार्य्यकारणम् ।
कथयामि च ते भद्रे पश्चात् स्थानस्य संपदः[1] ॥ 38.
आदौ सुवर्णनामानि संक्षेपात् शृणुतां प्रिये ।
स्वर्णं सुवर्णं सूर्य्यश्च हाटकं वह्निरोचनम् ॥ 39.
सु(स)रङ्गं च तथा लोहं देवधातुर्मनोहरम् ।
वैश्रौ[2] विश्वासगं चैव धर्म्मदं ऋषिदेवता ॥ 40.
जीवनम् अमृतं चैव हेमं[3] हिमवतोद्भवम्[4] ।
देववल्लभगं दिव्यं संसारोत्तारणं महत् ॥ 41.
जीवनं सर्व्वलोकानां[5] नारीणां रञ्जनं शुभम् ।
अन्यानि विविधनामानि[6] गोप्यगोप्यतराणि च[7] ॥ 42.
रजतं च तथा रूप्यं चन्द्रश्चन्द्रस्य दीपकम् ।
शुभ्रज्योतिःकरं[8] स्वर्णबद्वीजं तारकं तथा ॥ 43.
अनन्ता वर्त्तते तेषां कथा हस्तिकराश्च ये ।
स्थापितं लौकिकं चैव[9] येनाग्रन्यसमूहनम् ॥ 44.
शीतवीर्य्यं लघुवीर्य्यं विषघ्नं वातनाशनम् ।
रसपुञ्जीकरं श्वेतं धातुपुञ्जनकारकम् ॥ 45.
रतिदं बहुवीर्य्यं च शुभधाम च संचयम् ।

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(1) Both A and B read संपदि, which has no sense

(2) A reads वश्रौ ।

(3) हैम is generally used.

(4) हिमवद्भवं is the correct term

(5) The first term in the previous verse is only जीवनं । But here it is सर्व्वलोकजीवनं । Hence there is no repetition.

(6) अन्यानि विविधान् नामान्, an incorrect variant in A and B.

(7) गोप्यागोप्यतराणि च is the reading in A and B, which has no clear sense.

(8) A and B read शुभ्रज्योतिकरं, which is incorrect.

(9) A reads लौकिका येना, which leaves out चैव ।

एतानि रजतनामानि शतान्यन्यानि सन्ति वै[1] ॥ 46.
ताम्रं च[2] ताम्रकाधिष्ठं शुल्वं नागस्य मर्द्दनम् ।
नीलं च नीलविभ्रमं वमन[3] चैव पातकम् ॥ 47
उष्णम् उष्णकरं मिष्टं कर्कशं कालमर्द्दनम् ।
हैमगर्भं[4] च कामोटं विपटं विषनाशनम् ॥ 48.
आरक्तश्च सहायश्च[5] मन्मथो मार एव च ।
एतानि शुल्वनामानि अन्यानि विविधानि च ॥ 49
जासत्वं च जरातीतं राजतं यशदायकम् ।
रूप्यभ्राता वरीयश्च त्रोटकं कोमलं लघु ॥ 50.
चर्म्मकं खर्परं चैव रसकं रसवर्द्धकम्[6] ।
सदापथ्यं वल्लोपेतं पीतरागं सुभस्मकम् ॥ 51.
एतत्तु[7] खर्परनाम कार्य्यकर्म्मसु सिद्धिदम्[8] ।
रसराजार्द्रकं कर्म्म[9] कृतं सिद्धिषु[10] जायते ॥ 52.
त्रपुस्तापहरं वङ्ग रजतारिश्च[11] नीरदम् ।
शीतवीर्य्यकरं श्वेतं रतिदं तापहारकम् ॥ 53.
सिंहलं आह्लाद(?)भूतं सहायं धातुमिषयोः ।
एतानि त्रपुनामानि सुसिद्धं कार्य्यकारकम्[12] ॥ 54.

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(1) A has शतान्यानि वर्त्तने । B has शतानानि वर्त्तने । Both the readings are grammatically incorrect.

(2) च is dropped in A and B.

(3) The sense of नीलविभ्रमं seems to be नीलविभ्रम = नीलशोभम् । A reads चसनं, which is incorrect.

(4) A reads हैमगर्भं ।

(5) A and B read सहाय च ।

(6) रसचार्द्धक, the reading in A and B, is not grammatically correct

(7) तत्ते is the reading in A and B, which is incorrect.

(8) Both A and B read कार्यकर्मेषु सिद्धिदान्, which is grammatically incorrect.

(9) रसराजार्द्रकान् कर्म्मान्, an incorrect variant in A and B

(10) A reads कृते सिद्धिषु । B reads कृते सिद्धिषु । Both are incorrect.

(11) Both A and B read रजतानि च, which is senseless here

(12) सुसिद्धे कार्यकारकान्, an incorrect variant in A and B.

सीसकं[1] धातुभङ्गं च मृतकं रोचकं परम् ।
रक्तं च रक्तवीर्य्यं च[2] रक्तवस्तुविवर्द्धनम् ॥ 55.
अन्तरूप्यं च गम्भीरं धातुभञ्जनकारकम् ।
ग्राहकं रसराजेन अक्षोभ्याक्षोभणं परम् ॥ 56.
विचित्रं विनतं चैव नानारङ्गप्रदायकम् ।
नागं नगालयं प्रोक्तं सिद्धकं कण्ठशोधनम् ॥ 57
षण्ड[3] षण्डकरं चैव दुरितं षण्डकारकम् ।
एतानि[4] नागनामानि कार्य्यकाले प्रयोजयेत् ॥ 58.
लोहं च आयसं शूरं सूर्य्यकर्म्मविशारदम् ।
हन्तकं खननं स्वर्णमारकं[5] ताटकं मलम् ॥ 59.
अजरं च जरायुक्तं धात्वाद्यम् अवनीसुतम् ।
कालेयं जीषणं कालं रुधिरं रोगनाशनम् ॥ 60
ग्रन्थिदं सर्व्वधातुनाम् अक्षोभ्य जलवह्निषु ।
वह्निदं वह्निवीजं च सर्व्वधातुसहायकम् ॥ 61.
एतानि लोहनामानि ज्ञात्वा कर्म्माणि कारयेत् ।
जायते[6] सकला सिद्धिर्वियोगयोगसंयुता[7] ॥ 62.
नामानि धातुसंयोगे जातानि तानि च शृणु[8] ।
शुल्वखर्परसंयोगे जायते पित्तलं शुभम् ॥ 63.
पित्तलं चैव नारीकं कफदं गन्धदुर्ज्जयम् ।
वर्णदं दुर्व्वलं चैव राजतं वल्लभं लघु ॥ 64.

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(1) A and B read शीशकं ।

(2) B has only रक्त वीर्यं च, which is incomplete.

(3) A reads खण्ड खण्डकरं चैव ।

(4) A and B read एतत्ते, which is incorrect.

(5) A has स्वर्ण मारकं । B has स्वर्णे मारकं ।

(6) A reads नीयते ।

(7) वियोगायोग is the variant in A. वियोगायोग s the variant in B Both readings seem to be incorrect.

(8) जातानि च ते शृणु, an incomplete variant in A and B.

वङ्गताम्रसंयोगेन जायते तेन[1] कांस्यकम्।
कांस्यकं कोमलं चैव नैरसं रसकाठिनम्[2] ॥ 65.
तीव्रनादं महाशब्दम्[3] उग्रकान्ति रविग्रहम्।
ज्वालापिधानं रौद्रं च ग्राहकं[4] धुम्ररोधनम् ॥ 66.
एतानि[5] कांस्यनामानि कार्य्यकाले प्रयोजयेत्।
बन्धने धारणे चैव मुद्रणे धूमबन्धने ॥ 67
खर्परैः सह पारदं दिव्यं[6] किञ्चित् प्रमेलयेत्।
जायते रसको नाम नानारोगहरो भवेत् ॥ 68.
नागस्तु रहते[7] हीनो मृतधातुस्तु जायते।
स एव कोमलाग्निस्थः[8] सिन्दूर जायते ध्रुवम् ॥ 69.
अनेकाः[9] साधयेद्विद्या मन्त्रयन्त्रकरोः क्रियाः।
पूजनार्थे मम गुणाः सर्व्वे कल्पितरोचनाः[10] ॥ 70.
ताम्रदाहजलैर्योगे जायते तुत्थकं शुभम्।
नाना रसायनी विद्या साधयेत् सा[11] सदैव हि ॥ 71.
रसरसक(?)[12]योगेषु राजमर्य्यादा जायते।
राजकं जायते नाम नारी राजकलागतिः[13] ॥ 72
संयोगे साधनं दिव्यं वियोगे साधनं शुभम्।

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(1) A has जातेनैव। B has जायते तेनैव।

(2) A and B read erroneously कठिण।

(3) A reads महच्छब्दं। B reads महत्शब्दं। Both the readings are incorrect.

(4) A reads ग्याहकं, which has no clear sense.

(5) A and B read एतत्ते, which is incorrect.

(6) पारदो दिव्यो is the reading in A and B, which is incorrect.

(7) B reads रहरते, which is not correct.

(8) कोमलाग्निस्थे is the reading in A and B, which is not correct.

(9) A reads एनेका। B reads एतेका। Both are incorrect.

(10) A and B read कल्पितरोचनं।

(11) सा is not found in A and B

(12) A and B read रसारसयोगेषु, which is incomplete

(13) नारराजकलागनि, a variant in A नाराजकलागतिः, a variant in B Both the readings seem to be incorrect.

वियोगं पुनर्नैर्योगं रसताम्रे शुभो विधिः[1] ॥ 73.
अनेका साधनी विद्या साधयेद्द्रव्यकाङ्क्षितम्[2] ।
लभते रसायनीं विद्यां स्वस्थोऽपि विज्ञतोद्यमी ॥ 74.
अनेनैव प्रकारेण ज्ञायते नाम कर्म्मभिः ।
नामकर्म्मज्ञता[3]जाते चित्ते निर्म्मलता[4] भवेत् ॥ 75.
एतत्ते कथिता धातोरुपधातोस्तु तां[5] शृणु ।
येन विज्ञानमात्रेण कालकाख्या[6] न लिप्यते ॥ 76.
उपधातोस्तु मध्येषु श्रेष्ठा माता रसायनी ।
तस्या नामानि वक्ष्यामि पश्चात् स्थानगुणानपि[7] ॥ 77.
हरितालं विसङ्गा च रङ्गदीप्तिकरी सदा ।
तालं च हरिता हंसी श्वेतपीतविधायिनी ॥ 78.
नर्त्तकस्य प्रिया देवी निशा चैव निशाचरी ।
पारदस्य क्षयकरी पक्षच्छेदकरी स्मृता[8] ॥ 79.
रोगहा जीविनी जैवी जरादारिद्र्यनाशिनी ।
एतानि तालनामानि संक्षेपात् कथितानि ते[9] ॥ 80.
युक्तो ज्ञानेन यः[10] कर्त्ता अक्षोभ्यो[11] जायते सदा ।
अनेनैव प्रकारेण कर्त्ता कर्म्माणि साधयेत् ॥ 81.
मनःशिला शिला शृङ्गी कुनटी च क्षतोद्यमा ।
दरदा[12] भगिनी देवी सिन्दूरस्य सखी सदा ॥ 82.

(1) A and B read शुभविधिः ।
(2) A reads द्रव्यकोंखिन' । B reads द्रव्यकांखितः ।
(3) A and B read नामकर्मरदाजाते, which is unintelligible
(4) A and B read निर्लखा, which is not grammatically correct.
(5) A and B read ते, which is incorrect
(6) A reads कालकाय् । B reads कालकाय् । Both the readings are incorrect.
(7) Both A and B read गुणानि च, which is incorrect.
(8) The 78th and 79th slokas are not found in A
(9) संदिपे विकयानिते, a variant in A and B, which has no sense.
(10) युक्तज्ञानेन हि, an incorrect variant in A and B
(11) A reads अक्षोभ्यो, which is incorrect
(12) B reads देरदा ।

पुष्पा पुष्पवती[1] पत्नी शालिनी रसिनी शुणा।
एतत्तु च शिलानाम[2] कार्य्यकाले प्रयोजयेत्॥ 83.
अभ्रकं चैव व्योमं[3] च गगनं ग्राहकं परम्।
दुष्टवीर्य्यश्च वातश्च वह्निनादोत्नताकृति[4]॥ 84.
अजरम् अमरं घोरं घोरषण्डल[5]नाशनम्।
रसमूलरसातीतं रसज्ञं राज्यवर्द्धनम्॥ 85.
अमृतम् अमरं[6] चैव महामृत्युविनाशनम्।
एतान्यभ्रकनामानि ज्ञात्वा कर्म्माणि कारयेत्॥ 86.
सोमलं मल्लराजं च विषं वातविनाशनम्।
श्वेतवीर्य्यं बलग्रन्थि नीलउज्ज्वलकारकम्॥ 87.
स्वेदनं भेदनं चैव कामवीर्य्यविवर्द्धनम्।
बन्धनं सर्व्वधातूनां मारणं पारदे रवे॥ 88.
गगनग्राहके दिव्ये रसयुग्मे प्रमेलनम्।
एतानि मल्लनामानि कार्य्यकाले प्रयोजयेत्॥ 89.
हीनधातोश्च नामानि संक्षेपात् तानि च शृणु।
येन विज्ञानमात्रेण जायते पारदो क्रिया॥ 90
मुक्ता मुक्ताफल वारि वारिजं स्वातिसम्भवम्।
शुक्तिगर्भं[8] च सगर्भं शृङ्गारं मङ्गलोदयम्॥ 91.
तैजसम्[9] अमृतोद्भूतं शीतल शिलीमं मनः[10]।
स्वयम्भुवं कालं दीप्तं क्षिपि सौभाग्यदायकम्[11]॥ 92.

(1) A reads पुष्पवर्त्ती।
(2) एतत्ते च शिला मामान्, an incorrect variant in A and B
(3) Generally used as व्योम।
(4) A reads वह्निनादे एतः क्षतिः, which is incorrect
(5) A and B read खंडल, which is incorrect
(6) A repetition of the name
(7) A reads वते शृणु, which is incorrect.
(8) B reads शुक्तिगर्भं, which is not correct
(9) B reads तैनसं, which is incorrect
(10) B reads नमः, which is not correct.
(11) योप्ति सौभाग्यदायिन, an incorrect variant in A and B.

रतिराजग्रहः शोभाकामसन्दीपनं तथा ।
मुक्तानामानि रम्याणि[1] ज्ञात्वा कर्म्माणि कारयेत् ॥ 93.
विद्रुमं वरदं[2] वेलावल्लीजातं प्रवालकम् ।
नीरसम्[3] अधरंसीमा शिखरं शिखरोद्भवम् ॥ 94.
वर्णदं विवरं चैव ग्रैवेयं[4] च विभूषणम् ।
विद्रुमस्यैतन्नामानि[5] काव्यकाले प्रयोजयेत् ॥ 95.
चर्म्मकं कूर्म्मकं चैव कमठपृष्ठं[6] सकालकम् ।
कमठं कर्कशं चैव कलिङ्गजातमाशुभम् ॥ 96.
काचकं काहहुः[7] कर्म्म लोके काचकटं तथा ।
एतानि कूर्म्मपृष्ठस्य नामानि च विशेषतः ॥ 97.
शङ्ख च जलजं चैव देववादित्रमेव च ।
विष्णुवल्लभकं[8] चैव सोमदैवतकं शुभम् ॥ 98.
वरायुधं च वरदं शुभ्रं माङ्गल्यदायकम् ।
अजेयं सर्व्वजन्तूनां दानवास्थि वरोदयम्[9] ॥
गम्भीरं घोषशब्दं च पवित्रं पारदं रटद्दम् ।
एतानि[10] शंखनामानि वामदक्षिणकावुभौ[11] ॥ 100.
शुक्तिका सौफिका[12] कान्ती मुक्तामाता गरीयसी ।
चन्द्रपत्नी पयोग्राही संपुटी पटवादिनी ॥ 101.
रजताभासिनी दीप्ता वह्निवारिविशोषणी ।

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(1) A and B read ते रम्यान्, which is incorrect.
(2) A reads विद्रुमे वरदं । B reads विद्रुमे वरदे ।
(3) A reads नीरसे ।
(4) A and B read ग्रावेयं ।
(5) A has विद्रुमैनावि । B has विद्रुमैनामि । Both are incorrect.
(6) कलिंगमाशुभं is an incomplete variant in A and B
(7) A has कन्वककाहहुः । B has काचकहहुः ।
(8) B reads erroneously विष्णुवल्लभामकं ।
(9) Both A and B read वरं देय, which destroys both grammar and metre.
(10) A and B read एतत्ते, which is grammatically incorrect
(11) A reads वामदक्षिणपाकभौ । B reads वामदक्षिणमावुभौ ।
(12) B has only सीका ।

पद्मकरीगतिः पद्मगर्भ[1]समुद्रसम्भवा ॥ 102.
उत्तमा मध्यमा नीचा त्रिविधा सागरोद्भवा ।
नद्युद्भवा तु सा नीचा[2] नीचकर्म्मविशारदा ॥ 103.
एतत् लक्षणं शुक्तेः[3] कर्म्मकाले प्रयोजयेत्[4] ।
ज्ञात्वा यः कुरुते कर्म्म सिद्ध्येत् सकलं फलम् ॥ 104.
गजोद्भवं रदं[5] दन्तं द्विजं चैव तु पुष्पकम् ।
नारीसौभाग्यदं चैव गजभूषणसम्मुखम् ॥ 105.
तैलरक्षाकरं श्वेतं संपुटं पुटिकं तथा ।
नामानि गजदन्तस्य अन्यानि मध्यमानि च[6] ॥ 106
पिच्छकं कुकुंठं चैव शिखिपिच्छं सुचित्रकम् ।
हरिमौलिधरं श्वेतं मोहनं चन्द्रकं तथा ॥ 107.
नागारिं सर्पदमनं विषदं विषनाशनम् ।
एतानि शिखिपिच्छस्य नामानि विविधानि च ॥ 108.
नखं सहृदयपुरं[7] धातुकोमलकारणम्[8] ।
वज्रं[9] दुर्गन्धिकं चैव तुरीटापत्तु चोभकम्[10] ॥ 109.
कचं केशं च वालं च मूर्द्धजालकमेव च ।
श्मश्रं चैव घनं प्रोक्तं कर्कशं नर्म्मदं लघु ॥ 110.
एतानि धातुनामानि यथाकर्म्माभिधानकम् ।
ज्ञात्वा आरभ्यते कर्म्म स्वस्थे सिद्धिः प्रजायते ॥ 111.

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(1) A and B read पद्मगर्भ ।

(2) नद्योद्भवा तत्रोचा, an incomplete variant in A. नद्योद्भवा तत्रैवा, an incorrect and incomplete variant in B

(3) A and B read एतत्ते लक्षणा शुक्ति, which is an incorrect variant

(4) कर्मकार्ये प्रयोजने, a variant in A, which seems to be incorrect

(5) A reads वरदं, which is incorrect

(6) अन्यस्ते मध्यगानि च, a variant in A and B, which is grammatically incorrect.

(7) न हृदयपुरं, a variant in A. न हृदयपुरं, a variant in B Both are incorrect.

(8) B reads कारणं ।

(9) B reads वज्रे, which is not correct.

(10) A reads तुरीटापत्तुचोभकं ।

पार्व्वत्युवाच ।
शम्भो शङ्कर विश्वेश विश्वनाथ जगद्गुरो ।
श्रुतानि चैव नामानि स्थानानि कथ्यन्तां[1] प्रभो ॥ 112.

महादेव उवाच ।
शृणु देवि प्रयत्नेन स्थानानि विविधानि च ।
सुवर्णस्योदयो धातोः सर्व्वव्यापकपर्व्वते[2] ॥ 113.
पार्थिव्यं हि च तत् सर्व्वं[3] मृदामध्यात् प्रजायते ।
तस्मात् स्थानस्य संक्षेपः श्रूयतां सादरं[4] शुभे ॥ 114
हैमं च प्रथमं कल्पं मेरुमध्ये सदैव हि ।
दुर्ल्लभं मर्त्त्यलोकेषु कष्टेनैव तु लभ्यते ॥ 115.
पुनर्हैमाद्रिणा तेन जायते सर्व्वदा शुभे ।
महाशीतक्षते[5] तेन दुर्ल्लभं स्यात् सदैव हि[6] ॥ 116.
पश्चाज्जम्बूनदोद्भूतं जम्बूद्वीपेषु जायते ।
तच्च कष्टतरं मन्ये दुर्ल्लभं तत् सदैव हि ॥ 117.
पृथिव्यां धातुमध्येषु सर्व्वेषामधिकं सदा ।
लोहाधिकतरं तत्र ज्ञातव्यं सर्व्वदा शुभे ॥ 118
कष्टे निःसारणं तेषां मौल्यादधिकं जायते ।
तस्मात्तेनैव यत्नेन साधनं क्रियते नरैः[7] ॥ 119.
असाध्यसाधनं तस्य जातं सर्व्वयुगे शुभे ।
तस्मात्तु[8] बहुमूल्येन सर्व्वधातुपरिस्थितिः[9] ॥ 120.

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(1) A and B read कथ्यता, which is grammatically incorrect.
(2) A reads वर्तात । B reads पर्वात । Both the readings are incorrect.
(3) पार्थिव्यानि च ते सर्वे, an incorrect variant in A and B.
(4) A and B read सादरात्, which is incorrect
(5) A reads महत्सीतक्षते, which is incorrect.
(6) B reads सदैव हि, which is incorrect
(7) A has क्षयन्ते नरा. । B has क्षयते नरा. । Both are incorrect
(8) A and B read तस्मात्ते, which is incorrect.
(9) सर्वधातोपरिस्थिति, an incorrect variant in A and B.

पुनः स्थानं ज्ञातं तेन लङ्कायां च सदैव हि।
उद्धितं तेन यत्नेन मर्त्याद्[1]भीतं मया शुभे॥ 121

पार्व्वत्युवाच।

महारुद्र शङ्कर श्रीमन्[2] लोकनाथ जगत्पते।
कथं ते मानुषे भीतिः[3] काथ्यतां परमेश्वर॥ 122

महादेव उवाच।

सुवर्णस्यैषा महती[4] भीतिर्मानुषसम्भवा।
उच्चो नीचपदं सम्यक् जायते बहुले रतिः॥ 123.
मया मानुषभीतेन[5] उद्धितं सादरेण च।
दुर्ल्लभं च विशेषेण प्राक् कलियुगे इदम्[6]॥ 124

पार्व्वत्युवाच।

मदीये मानसे नाथ जातोऽसौ संशयो महान्।
भवतां मानुषी भीतिः कथं तु जगदीश्वर[7]॥ 125.

महादेव उवाच।

कारणं वर्त्तते देवि अव्याख्येयं सदैव हि।
कथनीयं त्वयि भद्रे यतस्त्वं[8] मम वल्लभा॥ 126.
बुद्धिचतुरताबुद्धिर्जायते च कलौ युगे।
मानुषे च भवतीह[9] मम क्षोभानुवर्त्तिनी॥ 127

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(1) A and B read erroneously मर्त्याद्।
(2) श्रीमान्, a reading in A and B, is not correct.
(3) मानुषाद्भीतिः is the correct form.
(4) A and B read सुवर्णस्यैषा महतान्, which is not correct.
(5) मा च मानुषोभीतेन, an incorrect variant in A and B
(6) A and B read इमे। This foot is incomplete.
(7) A reads कथं ते जगदीश्वरं। B reads कथं ते जगदीश्वरः। Both are incorrect
(8) यतेत्वं is an incorrect variant in A and B.
(9) A and B read भवंतीह, which is not correct.

तस्मात्सैवेष्टुले[1] द्रव्ये साध्यते गन्धकी क्रिया।
अथवा पारदो चैव मम च्छोभानुवर्त्तिनी ॥ 128.

पार्व्वत्युवाच।

श्रुता सा गन्धकी विद्या सर्व्वसौभाग्यदायिनी।
सङ्गभक्षकृता सा च[2] न सिध्यति गरीयसी ॥ 129.
भवता पूर्व्वमुक्तं हि सङ्गभक्षणयोगतः।
न सिध्यति च ते विद्या सदा गन्धकपारदो ॥ 130.
तस्मात्त् कथ्यतां देव मनो[3]ग्लानिविवर्जितम्।
सुवर्णसाधिनीं विद्यां[4] तस्माद्वदतु मे विभो ॥ 131.

महादेव उवाच।

मानसं मदीयं देवि जातं सम्यक् सुनिर्म्मलम्।
तथापि मानुषे भीतिर्विद्या[5] गन्धकपारदो ॥ 132.
सङ्गभक्षणजं कष्टम्[6] उभे मेलापनं महत्।
सुष्ठु मन्त्रकृते वह्नौ ज्वलते तत्क्षणात् ततः ॥ 133.
मन्त्रवत् साधयेद्विद्यां साधयेद्यत्नतः क्रमात्।
तस्मात्तेनैव महता गोप्या सिद्धिकरी क्रिया ॥ 134.

पार्व्वत्युवाच।

पुरा प्रोक्तं त्वया नाथ पटले पञ्चदशके[7]।
कैलासात् परमं सौख्यं भजते मन्त्रविज्जनः ॥ 135.
क्रिया गन्धकिनी[8] मध्ये अथवा पारदी शुभे।
कैलासादधिकं सौख्यं भुञ्जते विधिवन्नराः[9] ॥ 136.

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(1) A and B read तस्मात्से, which is incorrect.
(2) A and B read ते च।
(3) A reads मत।
(4) A and B read सुवर्णसाधिनी विद्या।
(5) A and B read विषे, which is senseless
(6) A and B have काष्ट', which is incorrect
(7) पटले पंचाधिके, a variant in A and B, which is incomplete.
(8) A and B read गधकिना।
(9) A and B read नरः, which is incorrect

महादेव उवाच।
निर्म्मलं मानसं जातं तव वाक्यविमोहितम्।
कथयामास ते भद्रे गुणलक्षणसंयुतम्[1] ॥ 137.
स्वर्णोत्पत्तिस्थलं[2] नित्यं सर्व्वत्रापि विधीयते।
उत्पादनगतिस्तस्य स्थानं स्थाने पृथक् पृथक् ॥ 138.
श्रूयतां वरदे देवि स्थाने चैव यथोदितम्।
तस्य वातोत्थजा रेणुर्धमनी स्वर्ण[3] जायते ॥ 139.
पावकाद्रिभुवावाहुः[4] सप्तरत्नाकरे तथा।
समुद्रस्य तटे दिव्ये स्थानं स्यात् स्वर्णकस्य च ॥ 140.
स्वल्पं च सिन्धुदेशेन कामरूपैस्तथैव च।
अन्यैस्तु विविधैः स्थानैः साम्प्रतोत्पत्तिर्जायते ॥ 141.
तत्र तत्रोत्पत्तिस्तेषां यत्र यत्र हिमद्रवः।
प्रसरन्ति भुवि संघाः[5] संशयो नास्ति ते सदा ॥ 142.
ताम्रोत्पत्तिश्च महता सुखेनैव प्रजायते।
तेषां स्थानानि वक्ष्येऽहं[6] याथातथ्येन च शृणु[7] ॥ 143.
नेपाले कामरूपे च[8] वङ्गले मदनेश्वरे[9]।
गङ्गाद्वारे मलाद्रौ च म्लेच्छदेशे तथैव च ॥ 144.
पावकाद्रौ जीर्णदुर्गे रूमदेशे फिरङ्गके।
एतान्युदितस्थानानि[10] सर्व्वपर्व्वतके[11] सदा ॥ 145.

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(1) A and B read संयुतः, which is not accurate
(2) Both A and B read स्वर्णोत्पत्तिः स्थलं, which is not correct.
(3) A and B add च after स्वर्ण।
(4) A reads पावकाद्रस्य शुभावाहु। B reads पावकाद्रस्य भुवावाहुः।
(5) स्मगे is the variant in A घ'गे is the variant in B.
(6) स्थानान् प्रवक्ष्येऽहं is the incorrect variant in A and B
(7) A and B read ते शृणु।
(8) नेपालं कामरूप च, a reading in A and B.
(9) वङ्गालं मदनेश्वरं, a variant in A and B.
(10) एतानि उदितस्थानात्, an incorrect variant in A.
(11) A and B read सपर्वतगे, which is incorrect.

जासत्वं यत्तु[1] दिव्यं हि स्थानानि तस्य च शृणु।
कुम्भाद्रावथ[2] काम्बोजे रूमदेशे बलच्चति ॥ 146.
एतान्युभयोः स्थानानि[3] रजःस्थान[4] च[4] उच्यते।
जासत्वं वङ्गले नागं नेपाले च सदैव हि ॥ 147
केदारे कर्म्मकाण्डे च त्र्यम्बके त्रिपुरे तथा।
एतत्स्थानानि दिव्यानि[5] गोप्यान्यन्यानि तानि हु[6] ॥ 148
लौहाद्रौ[7] लोहजातकर्म्म गयाद्रौ[8] गौतमाद्रिके[9]।
विन्ध्यमध्ये[10] हि सर्व्वत्र नलाद्रौ[11] निष्कलेऽपि वा ॥ 149
त्र्यम्बके विमले[12] चैव लौहाकशालिवाहने।
समुद्रस्य तटे रम्ये आद्ये अन्ते च मध्यगे ॥ 150.
लोहस्यैतानि स्थानानि[13] हाटकैश्च[14] सदैव हि।
किञ्चित्[15] गोप्यानि दिव्यानि संस्कारैः रहितानि च[16] ॥ 151.
युक्ते तु संस्कृते तेषु स्वर्णे सिद्धिः प्रजायते।
अयुक्ते नैव लभ्या तु[17] युक्ते प्राप्तिः सदैव हि ॥ 152.

(1) A and B read यत्ते।
(2) A and B read कंभाद्रेच, which is incorrect.
(3) एति उभयोः स्थानात्, a reading in A. एति उभयो स्थानात्, a reading in B.
(4) A and B read रजस्थानानि।
(5) A and B read स्थानकान् दिव्यान्।
(6) अन्या गोप्या तितेति हु, a variant in A and B, which is senseless.
(7) A and B read लौहाद्रे, which is incorrect
(8) Do Do गायाद्रे, Do
(9) Do. Do. गौतमाद्रिषे, Do
(10) Do. Do वंध्यमध्ये, Do.
(11) Do Do नलद्रे, Do.
(12) A reads विमले।
(13) लोहस्यैतानि च स्थानात्, a variant in A and B, which is incorrect.
(14) A reads हाटके च।
(15) केचित् is the reading in A and B, which is incorrect
(16) A reads ते। B reads ते।
(17) A and B read लभ्यंते, which is not correct.

पारदे गन्धके धात्वोः योग श्रौपधहृत्[1] सदा।
मानसे निर्म्मले चैव लभ्यते[2] हाटकी क्रिया ॥ 153.
अन्यथा नैव लभ्या तु[3] विना मन्त्रेण सिध्यति।
तस्मादेवं[4] प्रयत्नेन निर्म्मलं मानसं शुभम् ॥ 154.
अशुभं समलं चैव मानसं सर्व्वदा भवेत्।
तस्मात्तु चतुराहारे[5] सर्व्वदा शुभमानसः ॥ 155.
जायते च क्रिया सिद्धा हाटकी भवति सर्व्वदा।
मन्त्रसिद्धिः प्रजायेत सर्व्वकर्म्माणि साधयेत् ॥ 156.
अनेनैव प्रकारेण उत्तमा हाटकी क्रिया।
सर्व्वकार्य्यकरी नृणां चतुर्वर्गफलप्रदा ॥ 157

महादेव उवाच।
प्रोक्तसंपुटके चैव स्थूलकाचौथकेन च।
उष्णाङ्गारहृते अग्नौ[6] सुर्मूरं छागरेकजम् ॥ 9.
खर्परारव्ये पुटे चैव आरव्योसलकेन च।
सार्द्धं विनास्ति(?)गति च ज्वलिते अर्द्धमर्द्दणे[7] ॥ 10.
एवानुक्रमतो योगे पुटमेकं च जायते।
चतुरंशेन जासत्त्वं सुवर्णाद्दापयेत् सुधीः ॥ 11
प्रति संपुटपुटे चैव उद्धयेत् कुण्डखर्परे।
स्वाङ्गशीतं[8] समुद्धृत्य लेपमुत्तारयेत्ततः[9] ॥ 12

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(1) A and B read यौग्यौपधहृत्, which is not correct
(2) Do. Do लभते, Do
(3) Do. Do. लभ्यते, Do.
(4) Do. Do तस्मादेवं, Do.
(5) A reads चतुराहारे, which is unintelligible
(6) A reads हृतेऽग्नि। B reads धृतेऽग्नि।
(7) A and B read ज्वलितेरवैरवंगा।
(8) स्वागशीतेन is the reading in A and B, which is not accurate.
(9) A and B read लेपमुणारणं ततः, which is incorrect.

पुनर्लेपः प्रदातव्यः[1] पुनः क्षारान् प्रदापयेत् ।
पुनरेव घोटनं देयं सादरं पुनरेव हि ॥ 13.
अनेनैव प्रकारेण तुर्य्यांशसंपुटेन हि ।
सुवर्णसंयुतं तच्च[2] गालयेत् क्षारसंयुतम् ॥ 14.
ज्वलिते तोलयत्येव तिलार्द्धं संपुटं प्रति ।
नम्रीभूतं च रक्तिश्च संस्कारैः शुध्य साम्प्रतम् ॥ 15.
एतत्क्रमक्रमेणैव सुवर्ण[3]मनुसंचय ।
तद्गुणे शोणिमापीते भङ्गस्ततः प्रजायते ॥ 16.
आरक्तं पीतसंयुक्तं जायते हाटकं महत् ।
हाटकं मस्तकं[4] चैव न च हीनेन योजयेत् ॥ 17
कलागुणगते वृद्धिर्जायते उत्तमे नरे[5] ।
अनेनैव प्रकारेण मात्राद्विगुणं दापयेत् ॥ 18
कलात्रय[6]मिते वृद्धिर्दीपिता वृद्धिरिष्यते ।
निर्दोषं जायते दिव्यं द्रव्यसंपत्तिदायकम् ॥ 19.

पार्व्वत्युवाच ।

अधिकेन कृते तत्र[7] शोणपाने सुशोभने ।
जायते कीदृशं देव संयोगे अधिके सति ॥ 20.

महादेव उवाच ।

शोणपाने च संयोगे भङ्गदः अस्ति[8] निश्चयः ।
द्विगुण[9]शोणपानेन कलंकं जायतेऽशुभम्[10] ॥ 21.

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(1) A and B read पुनर्लेपं प्रदातव्यं, which is not correct.
(2) A and B read ते च, which is incorrect
(3) A and B read सुवर्णान्, which is not correct
(4) A and B read हाटके मस्तके चैव ।
(5) उत्तमो नरः, a variant in A and B.
(6) A and B have कलातर्के ।
(7) A and B have ते च, which is incorrect.
(8) A and B read भंगदा चास्ति, which is incorrect.
(9) Do. द्विगुणे ।
(10) Do. शुभं, which appears to be incorrect.

वेधसंगं सुधनार्थे त्रिंशांशे दिक्पलोपमम् ।
अतिरिक्ताक्षतं तच्च जायते सगुणं महत् ॥ 22.
गालयेद्‌यत्नपूर्व्वेण क्षायेद्रससमांशके ।
समांशे गन्धकं देयं शुद्ध पीतका[1]रागकम् ॥ 23.
त्रयतुर्य्यांशकं तालं दापयेद्रसमोदितम् ।
तदर्द्धं सादरं देयं मर्द्दयेत् कन्यकारसे ॥ 24.
यामत्रितयमामर्द्य[2] छायाशुष्कमथाङ्गजे रसे ।
अतिशुल्वेतरे खल्ले अथवा लोहसंभवे ॥ 25.
मर्द्दयेद्‌यत्नपूर्व्वेण छायाशोषितं कारयेत् ।
काचकूप्ये प्रदातव्यं[3] वह्निर्वालुकयन्त्रगः[4] ॥ 26
नखसंख्यामिते यामे पाचयेद्रसं शोभने ।
स्वाङ्गशीते तु संजाते पुनः खल्ले निधापयेत् ॥ 27.
रसेनानेन आमर्द्य छायाशोषितं कारयेत् ।
उत्तायामे रसे[5] दत्ते पुनः शोषं[6] प्रदापयेत् ॥ 28.
उत्ताग्नौ दापयत्येव पुनः संस्कारमाचरेत् ।
संस्कारे त्रिविधे जाते अग्निपूर्व्वे क्रमोदिते ॥ 29.
जायते रसराजोऽसौ सर्व्वसामर्थ्यदायकः ।
संचयेत्तण्डुलार्द्धस्तु अतिविक्रमवेगवान् ॥ 30.
जायते प्रबला वृद्धिः त्रिदिने सेवते यदि[7] ।
सार्द्धवृद्धिक्रमेणैव दिने मासफलं सदा ॥ 31.
जायते नात्र सन्देहः सिद्धिर्गन्धकसम्भवा ।
अनेनैव प्रकारेण रससिद्धिः प्रजायते ॥ 32.

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(1) A and B read पीयत, which is senseless.
(2) यामत्रयमामद्य, an incomplete variant in A and B.
(3) प्रदातव्या, a reading in A and B
(4) यन्त्रगा, a reading in A and B.
(5) रसौ is the variant in A and B
(6) शोषवे is the incorrect reading in A and B.
(7) A and B read सेवनेत्यपि, which is grammatically incorrect.

पार्व्वत्युवाच ।
श्वेतता कर्म्मणा केन[1] जायते रजतेषु च ।
कर्मणा राजतो सिद्धिः पश्चाद्धाटकसम्भवा ॥ 38.

महादेव उवाच ।
अथानन्तरता विद्या धातुसंस्कारकारिणी ।
जासत्वे[2] कठिने जाते शुद्धे कोमलकारिणी ॥ 39.
तथाच पीतशुल्वेषु जायते शुद्धनम्रता ।
शृणु यत्ने क्रिया दिव्याः शुद्धाजासत्वसम्भवाः ॥ 40.
पिष्टं हयखुरोत्थं च द्विगुणं धातुतः सदा ।
अर्द्धन्तु दापयेत् स्रावे अर्द्धं निम्ने च[3] रचयेत् ॥ 41.
निर्म्मलं धातुजं द्रावं स्रावचूर्णेन ढालयेत् ।
यदर्द्धं च स्थितं निम्नं तत्कालं दापयेत् सुधीः ॥ 42
उपरि संपुटं देयं समुद्रकुक्कुटे पुटे[4] ।
स्वाङ्गशीतं समुद्धृत्य जायते निर्म्मलं महत् ॥ 43.
जासत्वे सीसक देयम् उन्नभागेन[5] साम्प्रतम् ।
चुर्णान्तरगतं कृत्वा उज्ज्वल जायते महत् ॥ 44.
तदेव[6] जासत्वं चैव दिव्यम् उज्ज्वलगं सदा ।
रूप्यार्द्धं मेलयत्येव जायते शुद्धता शुभा ॥ 45.
अनेनैव प्रकारेण धनं किञ्चिच्च जायते ।
धने चैव तु संजाते कारयेद्दूर्जाः क्रियाः ॥ 46
अतीव शोभना विद्या रसगन्धकजा सदा ।
अतिसौभाग्यदा सा[7] च साधके सुखदायिका ॥ 67.

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(1) कैन कर्मेण, an incorrect variant in A and B.
(2) जासत्वं is the reading in A and B, which is not correct.
(3) A and B read निर्वेन ।
(4) समुद्रं कुक्कुटे पटे, a variant in A and B, which seems to be incorrect.
(5) उन्नभोगेन, a variant in A and B.
(6) A and B read तु एव, which is not correct
(7) Do. ते, Do.

एताहृशं च जासत्व श्रोधितं गन्धकेन च ।
धालधौतेन ताम्रेण पुञ्जितं[1] सुभग सदा ॥ 68.
पुञ्जितं जायते दिव्यं शुल्वपीतं शुभोदितम् ।
निर्म्मलं जायते तच्च हीनहाटकसन्निभम् ॥ 69.
लघुता जायते तस्य किञ्चिन्नार्य्यां गुरुता सदा ।
जायते गुरुता दिव्या पुञ्जिते हाटकेन च ॥ 70

२८श-पटलादुद्धताः श्लोकाः ।

पार्व्वत्युवाच ।
पूर्व्वमुक्तं त्वया नाथ धने सिद्धिस्तु जायते ।
लघुद्रवत्वति धातौ[2] वद[3] किं तत्र मुच्यते ॥ 43.

महादेव उवाच ।
क्रिया अग्नेः शुभा तेषां द्रव्यसिद्धिविधायिनो ।
शृणु यत्नेन तां भद्रे क्रियां रंगोति नागजाम् ॥ 44.
आनयेत् पारदं दिव्यम् अधऊर्द्धविपातितम् ।
क्षालयेद्‌यत्नपूर्व्वेण खल्ले पिष्टं तु कारयेत् ॥ 45.
तैलेनानेन आमर्द्य भावना क्षणमात्रतः ।
निम्ने डमरुके यन्त्रे अग्निं दद्याद्‌विचक्षणः ॥ 46
उत्थयेद्‌यामयुग्मेन स्वाङ्गशीतं समुद्धरेत् ।
पुनः समाननागेन पूर्व्ववत् क्षालयेत सुधीः ॥ 47.
पुनरेव हठाद्‌ग्नौ उत्थयामेन सिध्यति ।
रसे द्विवारके चैव हीनहेमोत्तमोत्तमः[4] ॥ 48.
तौलिके रक्तिकायुग्मं दापिते वर्णपञ्चकम्[5] ।
अनेनैव प्रकारेण जायन्ते षोड़श कराः ॥ 49.

(1) A and B read पु'ञ्जिते ।
(2) A and B read धाते, which is incorrect
(3) A reads वच । B reads वचः ।
(4) हीमहेमोत्तम., an incomplete variant in A.
(5) पंचकः is the reading in A and B, which is incorrect

द्रव्यवृद्धिकरं तच्च जायते नात्र संशयः।
पुनरेव क्रिया रम्या पारदे नागचारिणी ॥ 50.
द्विगुणे चारिते तत्र[1] जायते चन्द्रिका शुभा।
अभ्यासेन शिखिग्रीवा जायते नात्र संशयः ॥ 51.
पुञ्जिते हीनहेम्निन जायते क्रयविक्रयः।
अनेनैव प्रकारेण जायते धनसंपदः ॥ 52.
अतजर्ध्वं क्रिया या च[2] विद्या नागस्य सम्भवा।
रसे तु नागजे चैव विधिनानेन वर्त्तते ॥ 53.
तायते[3] सकला विद्या नागतैलस्य संभवा।
सर्व्वा सा[4] शोभना विद्या तीव्रदारिद्र्यनाशिनी ॥ 54.
अथातः संप्रवक्ष्यामि त्रपूणां विधिमुत्तमम्[5]।
येन विज्ञानमात्रेण जायते रजतं महत् ॥ 55.
अनेका राजती सिद्धिः जायते परमोत्तमा।
जायते धनसिद्धिश्च[6] जायते नात्र संशयः ॥ 56

पार्व्वत्युवाच।
वद वैभवदातारं[7] वङ्गं विज्ञानदायकम्[8]।
ज्ञात्वा सिद्धिमवाप्नोति गुणज्ञैः सौख्यकं च यम् ॥ 57.

महादेव उवाच।
आनयेच्छोभनं वङ्गं विन्ध्याचलसमुद्भवम्।
गालयेद्यत्नपूर्व्वेण ढालेत् कुष्माण्डजे रसे ॥ 58.

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(1) ते च is the incorrect reading in A and B.
(2) A and B read श्रे च, which is incorrect.
(3) A and B have तात्रे, which is incomplete
(4) A and B have ता, which is not correct.
(5) A and B have विधिमुत्तमा, which is grammatically incorrect.
(6) A and B have स्यात् instead of च, which is a tautology.
(7) दाता च, a variant in A and B.
(8) दायकः, a variant in A and B.

त्रिःसप्तकाद्भते तत्र[1] जायते निर्म्मलं शुभम्।
तदुत्थान् कारयेत् पत्रान्[2] शुचिविद्दान् यथोदितान् ॥ 59.
रक्षयेद्दयत्नपूर्व्वेण आनयेद्वर्त्तिकं[3] पयः।
भावयेत् शुक्तिकाचूर्णम् उज्ज्वलं वह्निशोधितम् ॥ 60
मर्द्दयेद्यत्नपूर्व्वेण यावल्लेपः सुलक्ष्यते[4]।
यवार्द्धं लेपयत्येव पत्रान् तु यत्नपूर्व्वकम् ॥ 61
छायाशुष्के च संजाते दापयेच्छुक्तिसंपुटे।
चूडाधो लेपयत्येव सन्धौ यत्नेन मुद्रयेत् ॥ 62
मेलितो माषगोधूमौ पिष्टलेपं प्रदापयेत्।
छायाशुष्के च संजाते मृन्मयं लेपं दापयेत् ॥ 63.
सुशुष्के च[5] गजे पाच्य[5] स्वाङ्गशीत[6] समुद्धरेत्।
जायते उज्ज्वलं वङ्गं वातशुष्कं तु कारयेत् ॥ 64
यः कश्चित् मूर्च्छितश्चैव[7] जीवयेज्जीवनक्रियाम्।
स हि वङ्गाश्रयेणैव[8] उज्ज्वलः कठिनो[9] भवेत् ॥ 65
अतिशुद्धतरं तच्च जायते नात्र संशयः।
सर्व्वकर्म्मकरं श्रेष्ठं नानाभागेन पुञ्जितम् ॥ 66.
भोगभागसमायुक्तं वङ्गं च गुणसंयुतम्।
लक्षणार्थे[10] धनार्थे च[11] संयोगे साधयेत् सदा ॥ 67.

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(1) ते च is the incorrect variant in A and B.

(2) A and B read तदोत्थान्, which is incorrect. The word पत्र is used here in the masculine gender.

(3) B reads वर्द्रिकं।

(4) यावल्लेपस्य लक्षते, a variant, which seems to be incorrect

(5) सुशुष्केन, a variant in A and B

(6) स्वागशीते, a variant in A and B.

(7) ये केचित मूर्छिते ते च, an incorrect variant in A and B.

(8) सर्व्वगाश्रयेणैव, a variant in A and B, which is unintelligible.

(9) A and B read उज्ज्वलं कठिनं, which is incorrect.

(10) B reads भक्षणार्थे।

(11) धनार्थे is omitted in B

जायते सुभगं तच्च संसारे शोभनं भवेत्।
अनेनैव प्रकारेण जायन्ते धनसम्पदः[1] ॥ 68.

पार्व्वत्युवाच।
तपो शुद्धतरे जाते का क्रिया वद मे विभो।
लक्षणार्थं धनसंपत्तेः क्रिया या च पृथक् पृथक् ॥ 69.

महादेव उवाच।
लक्षणेन[2] च नारीणां भिन्ना भिन्नेन वर्त्तते।
अनेका धनदा विद्या जायते सुभगा महत् ॥ 70.
अतीव शोभना सा च गुणसामर्थ्यदायिका।
येन विज्ञानमात्रेण साधके धनमुत्तमम् ॥ 71.
जायते नैव सन्देहो धनसामर्थ्यकं महत्।
अतिसौभाग्यसम्पत्तिर्जायते नात्र संशयः ॥ 72
आनयेत् शुद्धं तं वङ्गं गालयेत् टङ्कणैः सह।
पिण्याकसुरसे दिव्ये टालयेद्यत्नपूर्व्वकम् ॥ 73.
सप्तटालनतो शुद्धे कठिनं रजतोपमम्।
जायते नैव सन्देहः पुञ्जिते रजते शुभे ॥ 74.
रजतं जायते शुद्धं संभारं कारयेत् सुधीः।
अन्येष्वेव विधिर्दिव्यो दिव्यरजतसंभवः[3] ॥ 75
आनयेत् शोधितं वङ्गं तदर्द्धं पारदे क्षलेत्।
निधाय[4] शोभने खल्ले तुर्य्यांशे दापयेत्ततः ॥ 76.
मर्द्दयेत् कन्यकावीर्य्ये यामं षोड़श यत्नतः।
हंसपद्या रसे दिव्ये तत्समं मर्द्दयेत् सुधीः ॥ 77.

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(1) जायते धनसंपदा, a variant in A and B.
(2) A and B read भक्षणेन।
(3) दिव्यादिव्यं रजतसंभवा, a variant in A and B
(4) A and B read निधाप्य or निधाय्य।

समानाच्छरसेनैव मर्द्दयेद्यत्नपूर्व्वकम्[1]।
छायाशुष्के च[2] संजाते शोषान्ते[3] बालुके पचेत् ॥ 78.
अनेनैव प्रकारेण क्रमादग्निं प्रदापयेत्।
प्रहराष्टकेऽष्टकेनैव त्रिवारं हठं दापयेत् ॥ 79.
जायते च रसं दिव्यं भक्षणे च सुधासमम्।
नारीणां दापयेद्यत्ने संयोगे नागकेसरै:[4] ॥ 80
तदर्द्धः सुष्टु[5] गोधूमाः सहैवं तोलकार्द्धम्।
अतिसौख्यकरं तच्च[6] रक्तिमात्रार्द्धं वर्द्धते ॥ 81.
पुंसि अजगुणोपेते यथा च गंधकी गतिः।
नरार्थे भक्षणे यातो जातित्रयसमन्वितः ॥ 82.
अनेनैव प्रकारेण क्रमेण वर्द्धयेद्रसम्।
जायते रसजा सिद्धिः नात्र कार्य्या विचारणा ॥ 83.
शुल्वात् सुधाकरं वङ्गं गालयेद्यत्नपूर्व्वकम्।
तज्जलं शोषयत्येव शतांशे रसदापिते ॥ 84.
रजतं जायते शुद्धं कलाद्वात्रिंशतः स्फुटम्।
अन्यं वै मेलयत्येव विक्रये शुभदं महत् ॥ 85.
अनेनैव प्रकारेण जायते धनसंपदः।
साधयेत् सिद्धिदा विद्या देहसामर्थ्यदायिनी ॥ 86.
मेलयेद्भोगभागेन मर्द्दनाद्दरदो विधिः।
पीते भावनया अग्नौ[7] सार्द्धद्वन्द्वेन सिद्ध्येत् ॥ 87.
शुद्धताम्रे प्रदातव्यं शतांशे हाटकोत्तमम्।
जायते नात्र सन्देहो यथा जाम्बूनदोद्भवम् ॥ 88

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(1) यत्नपूर्व्वकं, a variant in A and B
(2) छायाशुष्केन, a variant in A and B.
(3) A reads शोशान्ते। B reads सोशान्ते।
(4) A reads नागकेशरै।
(5) B reads शिष्टु।
(6) A and B read ते च, which is incorrect.
(7) A and B read रग्नौ, which is incorrect

पार्व्वत्युवाच ।

ताम्रं च तुत्थजं दिव्यं जायते केन विक्रियाम् ।
वद विश्वेश्वर शम्भो सिद्धिं ताम्रविधानकीम्[1] ॥ 64.

महादेव उवाच ।

शृणु शुद्धक्रियां दिव्यां तुत्थताम्रस्य सम्भवाम् ।
येन विज्ञानमात्रेण साधयेद्रसकुम्पिकाम् ॥ 65
साधयेत् पञ्चामृत दिव्यं महासौख्यप्रदायकम् ।
ज्ञात्वा कालेन लीयेत संसारसुखभाजने ॥ 66.
आनयेत्तुत्थकं दिव्यं पीतगन्धकसम्भवम् ।
दापयेच्छोभने खल्ले अर्कक्षीरेण भावयेत् ॥ 67.
मर्द्दयेद्यत्नपूर्व्वेण याममात्रमखण्डितम्[2] ।
तेनैव धातुयोगेन सुवर्णं[3] सुलभतां व्रजेत् ॥ 68
एतादृशी परा धातुर्वर्त्तते धातुमध्यमा ।
सुलभा शुभदा प्रोक्ता मम सान्निध्यगा सदा ॥ 69.

पार्व्वत्युवाच ।

ये गुणा नागजे ताम्रे वद विश्वस्य वल्लभ ।
प्रयोजनवस्तु शक्यं चतुरेणैव चोदितम् ॥ 95

महादेव उवाच ।

अनेका गुणा[4] नागेषु पूर्व्वमुक्ता हि[5] पारदे ।
किञ्चित् शेषतरा ये च शृणु देवि प्रयत्नतः ॥ 96.
नागस्य सम्भवं ताम्रं मध्ये मेलापनं कृतम् ।
विभागे तु कृते तत्र[6] जायते कुम्पिका शुभा ॥ 97

(1) सिद्धा ताम्रविधानकं, an incorrect variant in A and B.
(2) A reads याममात्रमखंडितः । B reads याममात्रे मखण्डितः ।
(3) A and B read सुवर्णः ।
(4) अनेकान् गुणान्, a variant in A and B
(5) सुक्तानि पारदे, an incorrect variant in A and B.
(6) A and B read ते च, which is incorrect

तन्मध्ये गालयेन्नागं त्रिवारं यत्नपूर्व्वकम् ।
जायते निर्म्मलं स्वर्णम् उदितं चैव कुम्पिके ॥ 98.
विभागे मारुतं दत्त्वा अमृतं जायते शुभम् ।
उन्माकार्य्यकरायैते नान्यथा वचनं मम ॥ 99.
तस्मात् साधयते दिव्यं भूनागोद्भवजं शुभम् ।
अनेका साधयेद्‌विद्या रससामर्थ्यदायिका ॥ 100.

Colophon in A

इति श्रीरुद्रयामले उमामहेश्वरसंवादे सुवर्णकल्पे
सुवर्णप्रशंसा नामाध्यायः ।

Colophon in B

इति श्रीरुद्रयामले उमामहेश्वरसंवादे धातुमंजर्य्यां
सुवर्णप्रशंसा समाप्ता ।

Extracts from SUVARNATANTRA or SVARNATANTRA.

सुवर्णतन्त्रात् वा स्वर्णतन्त्रात्

उद्धृताः श्लोकाः ।

A = MS. from Benares *

B = MS. from Ramnákáli's ma*th*a, Dacca. †

श्रीगणेशाय नमः ।

श्रीराम उवाच ।

देवदेव महादेव ऋद्धिबुद्धिफलप्रद ।
पूर्व्वं संसूचिता ऋद्धौ रसायनपरा परा ॥ 1.
यस्याः साधनमात्रेण स्मरात्तुल्यो नरो भवेत् ।
तां सिद्धिं वद मे देव यदि त्वं भक्तवत्सलः ॥ 2.
पूर्व्वं तु कथितं देव रत्नतन्त्रं त्वया मम ।
गुटिकाः कथिताः पूर्व्वं सहस्त्रद्वितयं शिव ॥ 3.
पारदाः कथिताः पूर्व्वं षट्शतं मृतिरूपकाः ।
धातूनामष्ट कल्पास्तु पूर्व्वमेव प्रकाशिताः ॥ 4.
धातुयोगाख्यकल्पस्तु पूर्व्वमेव प्रकाशितः ।
रत्नानां करणे तन्त्रं पूर्व्वमेव प्रकाशितम् ॥ 5.
किन्तु स्वर्णाख्यतन्त्रं तु न मह्यं कथितं प्रभो ।
काश्यपेन महेशानात्प्यर्दितोऽस्मि महेश्वर ॥ 6.

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* The name of this MS. is सुवर्णतंत्रम् ।

† The name of this MS is स्वर्णतन्त्रम् ।

भूमिदानं मया दत्तम् ऋषये कश्यपाय वै ।
कश्यपेन मयि प्रोक्तं भूमिभागं त्यज प्रभो ॥ 7
स्थानार्थं तु महेशानं रत्नाब्धिः प्रार्थितो मया ।
बाणमात्रं स्थलं तेन दत्तं मम महेश्वर ॥ 8.
स्थानं प्राप्तं महेशान भक्षणं मम नास्ति वै ।
भक्षणं देहि मे देव यदि पुत्रोऽस्मि शङ्कर ॥ 9.

ईश्वर उवाच ।

शृणु राम प्रवक्ष्यामि रहस्यातिरहस्यकम् ।
स्वर्णतन्त्राभिधं तन्त्रं कल्परूपेण कथ्यते ॥ 10.
तत्राद्यं स्वर्णतन्त्रस्य कल्पं शृणु सुपुत्रक ।
तैलकन्दाभिधः कन्दः सिद्धकन्दः प्रकीर्त्तितः ॥ 11
कन्दः कमलवत्तस्य पत्राणि कज्जवच्छ्रिया ।
तथैव तु मद्रूपत्रं तैलं स्रवति सर्व्वदा ॥ 12.
जलमध्ये सदा पुत्र त्वार्द्र एव प्रतिष्ठते ।
विषकन्देति विख्यातो विषाच्च कायनाशनं ॥ 13
तैलस्रावी महाकन्दः परितस्तैलवज्जलम् ।
दशहस्तमिते देशे सरते तैलवज्जनम् ॥ 14.
महाविषधरः पुत्र तदधो वसति ध्रुवम् ।
कन्दाधः कन्दच्छायायां नान्यत्र गच्छति प्रिय ॥ 15.
तत्परीक्षाविधानार्थं कन्दे सूचीं प्रवेशयेत् ।
सूचीद्रावः क्षणात् पुत्र तत्कन्दन्तु समाहरेत् ॥ 16
तत्कन्दं तु समादाय शुद्धसूतं खलेत्त्रिधा ।
मूषायां निक्षिपेत् तन्तु तत्तैलं तत्र निक्षिपेत् ॥ 17.
दीप्ताग्निं तु महाराम वंशाङ्गारेण दापयेत् ।
तत्क्षणान्मृतिमायाति लक्षवेधी भवेत् सुत ॥ 18.
ततः प्रभक्षयेद्राम क्षुन्निद्राहारको ध्रुवम् ।
तालं शुद्धं समानीय तत्तैलेन खलेत् सुत ॥ 19.

सप्तधा प्रत्यहं राम त्वेवं विंशद्दिनं ध्रुवम् ।
हरितालो मृतिमिति निर्धूमो जायते ध्रुवम् ॥ 20.
अग्नौ पुत्र ततो दद्यान्निर्धूमो जायते सुत ।
तत्तालं चाष्टधातौ तु दद्याद्द्रावे कृते सति ॥ 21.
सर्ववेधी भवेदेव शतविद्धो भवेत् सुत ।
तत्तैलं तु समादाय ताम्रद्रावे विनिक्षिपेत् ॥ 22.
तत्क्षणात्ताम्रवेधः स्यात् दिव्यं भवति काञ्चनम् ।
वङ्गे कांस्ये यदा दद्यात्तदा रौप्यं भवेत् सुत ॥ 23.
ताम्रे लौहे तथा रौप्यां तारे खर्परसूतके ।
तत्क्षणात् वेधमायाति दिव्यं भवति काञ्चनम् ॥ 24.

शंखद्रावस्य भेदान् हि तत्कल्यान् शृणु साम्प्रतम् ।
लौहद्रावस्तथा ताम्रद्रावश्चैव द्वितीयकः ॥ 1.
शंखद्रावस्तृतीयः स्यात् हृत्तालश्च(?)चतुर्थकः ।
दन्तद्रावः पञ्चमः स्यात् अक्षवेधी तु मध्यमः ॥ 2.
पञ्चानां तु परिक्षा वै कथ्यते शृणु साम्प्रतम् ।
लौहसूचीं समादाय लौहद्रावे विनिक्षिपेत् ॥ 3
तत्क्षणाद्द्रवतां याति सा सूची नात्र संशयः[1] ।
ताम्रद्रावे तथा सुचीं सन्धिभेदीं विनिक्षिपेत् ॥ 4.
सूचीद्रावो याममात्राद्भवत्येव न संशयः ।
शंखद्रावे शंखसूची चतुर्यामेन संद्रवेत् ॥ 5.
हृत्तालोऽधो[2] यदा गच्छेत् दन्ताद्याश्च भवन्ति हि ।
दन्तद्रावोऽप्यधो गच्छेद्दन्तद्रावो भविष्यति ॥ 6

The above 24 Slokas are not found in MS A.

(1) The above 7 hemistichs are not found in A

(2) A reads दताधाधो । B reads दन्ताद्याधो । Both the readings seem to be incorrect, since B has हृत्तालश्च चतुर्थकः in the 2nd Sloka.

एवं परीक्षां कृत्वादौ प्रयोगानारभेद्ध्रुवम् ।
वज्रमूषां ततः कृत्वा शुद्धसूतं विनिक्षिपेत् ॥ 7.
लोहसूचीद्रावरसं तत्र यत्नेन निक्षिपेत् ।
तत्राग्निं दापयेद्यत्नात् पुनस्तत्र[1] रसं क्षिपेत् ॥ 8.
स सूतो मृततामेति[2] नात्र कार्या विचारणा ।
अष्टधातुषु तं सूतं दत्त्वा काञ्चनतां व्रजेत् ॥ 9.
तं सूतं भक्षयेद्यो हि सोऽमरत्वमवाप्नुयात्[3] ।
तस्य मूत्रपुरीषेषु शुल्वं[4] भवति काञ्चनम् ॥ 10.
ताम्रद्रावप्रयोगं वै शृणु यत्नेन साम्प्रतम् ।
तद्रसं तु समादाय शुद्धताम्रे विनिक्षिपेत्[5] ॥ 11.
तत्ताम्रं स्वर्णतां याति भैरवस्य प्रसादतः ॥ 12.

Colophon in A—इति श्रीसुवर्णतंत्रे हरपार्वतीसंवादे दुग्धमांकल्पः द्वितीयः ।

Colophon in B—इति स्वर्णतन्त्रे लोहद्रावादिपञ्चफलकल्पो द्वितीयः ।

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(1) B reads पुनस्तस्य, which is not correct.

(2) B has सा सूतो मृतिमाप्नोति ।

(3) A reads स गच्छेदमरत्वता, which is incorrect.

(4) B reads तुल्य ।

(5) शुद्धताम्रेषु निक्षिपेत्, a variant in B

TIBETAN TEXTS

TIBETAN TEXTS

I

Sarveśvararasāyana

(Transcribed from the Tibetan xylographs by Paṇḍit Vidhushekhara Bhattacharya)

[Mdo. Go la 1] rgya.gar.skad du/sarveśvararasāyana
-rogaharaparipustaka nāma/
bod skad.du/thams.cad kyi [2] dbaṅ phyug.
bcud.len nad.thams cad.'joms.
śin.lus kyi stobs.rgyas.par.
byed.pa.žes bya.ba//
thams.cad.mkhyen.pa.la. [3] 'tshal.lo//

1. daṅ . por . dṅul.chu.sbyaṅ.ba'i.don.du.so.phag.gi.phya. ma.daṅ.sbyar la lan.bdun.gyi.bar.du.btags.śin sbyaṅ.[4]par.bya'o/ de'i.skabs su.yan.ñi.ma.la.bdug.por.bya'o//

2 śin.a.kon.gyi.'o.mas lan bdun.gyi.bar.du.btags.śiṅ. [2a1] sbyar.bar.bya'o/de'i skabs su.yaṅ.ñi.ma la.bdug.par.bya'o//

3. yaṅ.śiṅ.ba 'un gyi 'o.mas snar.bžin.no//ka.ndi' i. [2] žes bya.ba'i.śin.tshe.ram.caṅ.gyi khu. bas. sñar. bžin. no//ku. ma. ra. (x ri) 'i.khu.bas.snar bžin.no//tsi.tra'i.khu.bas.snar.bžin no// mdzo. [3] tshva.khu.bas.snar.bžin.no//sman.de (x da). rnams. bkrus.śiṅ.dṅul.chu.bzuṅ.no//

4. lin.gi.žes.bya. ba. 'i.sman. 'dab ma.gsum.pa/ro.tsha.ba [4] me.tog. mo (x ma) d.pa.daṅ./sdoṅ.bu.thog (X mthog) btsam.-yod.pa'ikhu.ba.blugs.nas.btags.pas skram.śin skud.pa.ltar.draṅ.-du.'dod.par.'gyur.ro//

5. [2 *b*.1] zaṅs.sbyoṅ.bar.dod.pas.srab.mor.byas.la.skyur [X skyar]. po'ı.naṅ.du.žag.bdun.gyi.bar.du sbaṅ.no/dar.ba'ı.chur. khu.la.yaṅ.de.bžın no/legs.par.bkru.bar. [2] bya' o/de.nas.zaṅs.-daṅ.mu.zi.mñam.par.byas.la.dza.go (*for* rdza.bo). naṅ.du.du.-ba.mi.'chor.bar.bya'o/dnul.lta.bur.dkaı.por.'gyur.ro//

6. gša' (X bša) tshe.sbyoṅ.ba [3] la.boṅ.khu.bas.snar.bžın.-no//

7. lcags.bsar.par.'dod.pas.ba'ı.chu.la.'bru.gsum.btab.la.srab.-mor.byas.la.bžug.go//bcug.pa.ni.bsreg [4] pas.so//phyınas.kyaṅ.-'bru.gsum.bcug.la.zaṅs.bžin.no//

8. lhaṅ.chor bsod.par.'dod.pas.žıg.tu btags.la.skyur(X skyar). pos.bcug.la.zaṅs.bžin. [5] no//

9 a.ra.dha.'ı.lo.ma.nı.gñen.po. (or gñan) yın. te.zaṅs. bžın.-no//.ba'ı.lca.thag (?) .kha.mnan.par.bya'o//

10. rjo.pha.wan bsad.par.'dod.pas.gı. (X kı).rı.gan.dha'ı.lo. [3 *a*.1] mas.ñı.ma.la.lan.bdun.budg par.bya'o./mar.khu.cha.na. bcug.pa.snar.gyi.zaṅs.bžın.no.dkar.por soṅ.ba.nı.'byoṅs.pa'o//

11. [2] dnul.sbyaṅ.bar.'dod.pas.nır.bı.sı'ı.khu.bas.lan. bdun.-gyı.bar.du.lcags.bžın.du.bsar.bar.bya'o//

12. jı.ltar.dnul.chu.bsar.ba.bžin.bh'ı.ma.la.yan. [3] bsar.-bar.bya'o//

13. gser.sbyaṅ.bar. 'dod.pas.ka.rtsa.na 'ı.khu.bas.jı.ltar.-zaṅs.bsod.pa.bžın.bya'o//

14. ji.ltar.gser.gsod.pa.bžın.su.pa.kı.ta.yaṅ.de 4 bžin.no/

15. de.ltar.sbyaṅ.ba.thams.cad.cha. mñam.por.byes.la.a.-ba.ra.nı.cha.gsum.mo//de.ltar.žıb.tu.btags la.goṅ.bur.bya'o. / nad. pa.la.ra.tı.bžı. 5 bži.byın.na.nad.thams.cad.'phrag.go//

16. skyur.po.dan.sno.sban.no / phye.dan.khur.ba'n.drug.-tu.zas.na.skra.dkar dan.gñer.ma.spon [3 b. 1] zla.dan.mñam.mo /mtshon.gyis ma.tshod.cin.bud.med.la.khu.ba. 'pho.bar.mi.-'gyur.ro./zla ba.drug.gi.bar.du.grub.phyin.na 'byin.ba bsad.do//

Dban.phyag.gis.bstan.pa'i rin.po.che'i bcud.len grub.pa.rjogs.-so//

TIBETAN TEXTS

II

Dhātuvāda[1]

(Transcribed from the Tibetan xylographs by Pandit Vidhushekhara Bhattacharya)

[45 *a*. 4] rgya.gar.skad.du/dhā.tū.vā.da.nā ma//
bod skad.du/ [5] gser.'gyur.gyi.rtsi.žes.bya.ba//
yum rdo rje.phag.mo.la phyag.'tshal.lo/

1

sbyin.pa'i.pha.rol.i dzogs.pa'i.phyir/
gser.'gyur.rtsi.yi.gdams.pa.ni/
ñams.su.len.pa'i.gan.zag.la/
tshogs.ni.bsag.phyir.bśad.par bya//

2

bil.ba.se'u.sman.tshos.dan/
se.'bru.rab.tu. [6] bregs.nas[2]
chan.skyur.dan.ni.sbyar.bar bya/
zans.kyi.snod.du.žag.gsum.bžag//

3

de.nas.bdun.gsum ñi.śu.gcig/
žal.gyi.gdams.pa'i sman.tshi.yis/
srab.mo'i.lcags.rnams.zans.su.'gyur//

---

1 In this text the abbreviations VX and CX are for the xylographs belonging to the Visvabharati and the Calcutta University respectively

2. The actual reading of the first two lines of the present stanza, as found in the xylograph, is as follows ·

bal.pa se'u sman tsha dan
sa'u.ra bsregs sa/

Evidently it is defective, and so I propose to read them as in the text
—V.B.

4

dṅul.chu.daṅ.ni.kham.so.daṅ/
sems (?) 'rtsi.daṅ.ni.lchi.ba.ni/
[7] le.gar(?) byas.nas.de.yi.dbus/
zaṅs mar.bžag na dṅul.du.'gyur//

5

rta.mig daṅ.ni.lug.ru.daṅ/
rus[3].sbal.śun lpags.śi.lar.bcas/
bžus.pa'i gser.la.dṅul.btab nas/
de.rnams.bsdus.pa'i cha brgyad.kyis/
bžus pa'i.ža.ñe.btab byas.nas/
lts.ba. [45 b. 2] ltad.ni.dṅul.'gyur//

6

dṅul.daṅ 'khar.ba.mñam.byas.nas/
ža.ñe'i.tshad.du.bsre.bar.bya/
phyi la[4].snod.kyi.naṅ.du.ni/
žu.bas.thams cad.dṅul.du.'gyur//

7

śa chen sran.ni.brgyad.daṅ.ni/
ža.ñe.dkar.po.de daṅ.mñam/
sa.j'i.sraṅ.gñis.sman.tsha.daṅ/
dug.bsad[5]. [2] gcig.daṅ.dṅul.chu.mñam/
gdos[6].can.sman.ni khu.ba.yis/
sda.ma'i.sman.rnams.mñe.bar.bya/
thams.cad.rva.dkar.naṅ.du.bcug/
yaṅ.na.rdja.sa'i.snoṅ.du.ni//

---

3. VX *ru.*
4. VX *phye.lta'i* for *phyi.la.*
5. VX *pas.*
6. VX *gdas.*

8

kha.sbyor.byas.nas.bsreg.bar.bya,
sman.thal.bar.du bžag.nas.bton/
dṅul.ni.zla.ltar.grub.'gyur//

9

[3] skyes.pa tsam.gyi[7].śa.ru.yi/
bu.ri.śa.ni.blad.byas.nas/
ñi.ma.žu.nas.btab.bar.bya/
de.ni.bzu[8].'gyur.phye.yis.ni/
ža.ñe.dkar.po'i.žun.mar.la/
btab.nas.chu.skam[9].dṅul.du.'gyur//

10

sman.tsha[10].dan.ni.tsha.le.dan/
ya.ba.kśa.ra.sa.dzig/
rtsi.dkar.sman.ni.khu.ba. [4] dan/
dug.dan.ha.nu.man.ta.yi[11]/
chu.ni.ma.ha'i.žo.dan.sbyar/
žag.gsum.ža.ñe'i.nan.du.bžag/
du.ba.mi.'byuṅ.thabs.kyis.bsreg/
dṅul.'gyur.'phons.pa'i.sdug.bsṅal.sel//

11

dṅul.'gyur.sbyor.ba.bśad.byas.nas/
gser.'gyur.bdud.rtsi.bśad.par.bya//

12

gans. [5] can.ri.bo.nams.la.ni/
ru.rta ste[12].žes.sman.mchog.grag.la/

---

7 VX *gyis* 8. VX *bži.* 9. VX *skams*
10 CX *tshad.* 11. CX *ma sa.ti'i* for *man.ta.yi*
12. VX *ta.*

lo ms sa phyogs zil mı bral/
gser.gyı mdog can khu ba 'dzag/
ža ñe.dkar po dnul chu ldan/
tnal sbyon žal gyı gdams pa yıs/
reg pas.dnul zans gser.du'gyur//

13

dan po me yıs dnul [6] chu yı/
mı 'tshor pa yi sbyor ba bya/
de nas sman gyi rtsı šes nas/
rnal 'byor gser 'gyr 'grub 'gyur ro/
me dan lhan cıg ma gnas na/
gser 'gyur 'grub par mı 'gyur ro//

14

de'i phyir kha sbyor.'khor.lo yıs/
bcıns[13] nas dnul.chu bcın bar bya/
de bcıns gan [7] yan gser du.'gyur/
[14]thams cad rdo rje'ı sku ru.'gyur/
gser.'gyur rtse'ı gdams pa slob dpon/
na lıs mdzad pa rjogs so//

13. VX *cı.*

14. Here ın VX and CX we have *ze pa.pa.la* or *zes.pas (?)* before *thams*, but as the metre shows, ıt ıs not requıred, nor does ıt gıve any sense. It seems to have been added here from a margınal note

rdo rje. means *vajra* 'dıamond' (or *śūnyatā*), or 'thunderbolt'. *sku.ru* means 'water-wheel', but ıt has no connectıon here *thams cad.rdo.rje. skur 'gyur* wıll, however, be ın Sanskrıt *sarve vajrakāyā bhavantı.*

TIBETAN TEXT

III

Rasāyanaśāstroddrti

(Transcribed and translated from Tibetan xylographs by Suniti Kumar Pathak, Visvabharati University, Santiniketan)

[Folio 3b line 2] rgya.gar.skad.du/ra.sa.ya.na.sa.stra-
[3b · 3] u-ddṛ-ti/

bod.skad.du/gser.'gyur.gyi.bstan.bcos,bsdus pa/
thams cad.mkhyen la.phyag.'tshal.lo//

1

kun.mkhyen ži.ba kun ster ba/
dpal mgon mchog.tu ži bar mdzad/
lons spyod. [3b 4] grol ba rab.ster bai/
dban.phyug.dam pa[1] phyag 'tshal lo//

2

phra.dan.sbom.las rnam.par grol,'
gsal dan mi.gsal mchog tu ži/
dpal dan.lons spyod gal ster.ma/
mchog.gi.dban. [3b 5] phyug.mar.phyag.'tshal//

3

mchog tu.sra.bai.dnul chu yi/
las kyi.sbyor.ba ńes par sbyar/
de.ñid rab sbyor mtha' la ni/
yon.tan skye bar 'gyur ba ste//

---

1. *par* is more suggestive

4

rgyal ba yis ni nad 'joms śin/
smin pa yis ni dbul po spoṅ/
bciṅs pa yis ni mkha. la 'gro/
dnul chui yon tan rnam gsum mo//

5

gal.te lhan cher.smin ni yon tan brgyad/
mu ži žu gyur[2] .'di la yon tan drug/
dnul chu mñam du gser gyis.ñes bcins na/
khoyd kyi mkha 'la 'gro ba.gan gis 'gog//

6

gsa' tse dnul chu ro yis mnam du.bsnun/
de phyed zla ba gñis.pai rim pa yis/
gsa tshe zla bai phyogs gsuns.gser.sbyor las/
zans ma drug.cu rtsa bži.'bigs par byed//

7

de.ñid.thig le.mi.gtor śin/
dmar skyai mdog ni.nor.ster.ro/
me.la gnas śin mi.gyo gi/
nam mkhat. [4*a* : 3] smin.pai.mtshan.ñid do//

8

gan.la dnul chu mnam du bžu/
dnul dan.yan na gser dag.gam/
gcig tu gyur cin.mi.zad.pa/
de.ni.bcins.pai.mtshan.ñid.do//

---

2 Alternative reading can be suggesged *žun pa* (melted Jäschke = J).

9

lhan.tsher.žu.ba.gaṅ.žig.gis/ [4a . 4]
dṅul.chu.dbaṅ.du.byas.gyur.na/
de.yis.chos.daṅ.nor.dag.gi/
sgo.dag.ñe.bar.ñe.ba.yin//

10

kha.yaṅ.nam.mkha.'ža.ba daṅ/
ser.po.ra.bas.mu.zi.daṅ/
gser.gyi.mṅal gyi.khu ba.ñid/
nor.'dsin.steṅ-na. [4a . 5] śin.tu.dkon//

11

rñiṅs.min.ma.yin.khyab.par.yi/
dmar.min.ma.yin.gžan.mi 'tshe/
smin.daṅ.rñiṅs pa.ñid.kyis.ni/
bye.ba.rnams ni.'bigs.par.'gyur/
te.nas.dṅos.poi.graṅs.brjod.de/
od.ldan. [4a 6] lcags.ni.mchod tu.'gyur//

12

de.dṅos.med.na.lcags.rṅon.po/
ra.gan.žo phyed.gśa.'tshe.zaṅs/
sgra.gcaṅ.gser.daṅ.dkar.po.rnams/
lcags.rnams.brgyad.du.gsuṅs.pa.ste/
dṅul.chui.smin.pa.so. [4b : 1] so la/
sbyaṅ.ba.ñid.du.bya.ba.ste//

13

gser.'gyur.las.la.dṅul.chu.rnams/
mu.zi de.bžin.dri med.daṅ/
ma.ksi.ka.daṅ.de.bžin.mtshal/
ku.nṭi.ka.si.ki.drug//

14

gser.gyi.btsag.dan.ba.bla.rnams/
ses.rab.ldan.pas.'ban.pas.sbyans/
mkhas.pas [4b . 2] las.rnams.ses par.bya//

15

gser.gyi.las.rnams ba.bla.yis/
kha.dog.ser.dan.dkar pos.khams/
lhan tscher.de.bžin.so.bi.ra/
ka.gu.sa.dra.rnams.so sor.smin//

16

de.rnams rtags.ni.bšad.par.bya/
sbyans.pas khu ba.rnams.ni ltun/
od.ldan. [4 b 3] yan.žin.khu.ba.dkar/
rnon po.mchog.tu.rnon.por.'gyur//

17

žans.ma.dmar.dan.sra.ba.ste/
rigs ni.gsum.du dbye.ba las/
bal.yul.las byun.mchog.yin te/
'dab mar gyur.ba.'brin du rig/
tha.ma.od.kyi[3] .dri.mar šes//

18

las.ni.legs. [4 b : 4] bar.sbyar.bar.bya/
sbyans.pas.khyab byed.ñid.dan.ni/
dnul.chui.smin.pa.ñid.la.phan/
ža.ni.nag.po.dkar.bar.šes//

19

ran.bžin.yan.žin.khu.ba.can/
gša.'tse.dri.dan.ldan.pa.mchog/

3. Here *kyi* means 'and'

tshogs.pa.nag.cin.myur.tu.'ju/
myur.du.'ju.bai.ran.bžin. [4 b : 5] gyis/
dkar.por śiṅ.tu.yoṅs.su.grags//

20

ra.ga.na kha.gser.'dra žin/
dri.ma len.ciṅ.dri.dan.ldan/
drag.cin.brtan.pai.khu.ba.ñid/
žaṅs.kyi.khames.ni.mthugs.pa'o//

21

sgra ldan.dri.ma.yan dag.ldan/
sra.žin.mchog.tu.brtan.'gyur.ba/
žaṅs.dan.gśa.'tshe. [4 b · 6] dag.bsres.ba/
mthug.cin myur.du.'ju bao//

22

bcan[4] .na dgar.žin.bdar.na.ser/
bsregs.na.gur.gum.lta.bu.dan/
snum.dan.ñum.nus.lce.ba ste/
gser.gyi.mtsan.ñid.rnam.pa.drug/
skar.ma.ku.ndai.mdog.dan.mtshuns/
snum.dan.skar ma.rab.tu.ster//

23

[4 b . 7] yon.tan.drug nu.rtsa.bži.ni/
rigs.kyi.mtshan.nid.dag.tu bśad/
snon.rjes[5] .ji.ltar.de.bžin.du/
bsdus.nas.bdag.gis.rab.bśad bya//

---

4 *bcan* conveys no meaning here Better reading *bcad*<*gcad pa*, 'to cut'. (J 148).

5 Ms. reads *rjas*. Mss. illegible, probably *ku-ndai* (a kind of flower), not kuntai

24

od.ldan la.sogs lcags.rnams.kyis/
sbyans nas.sñin stobs.dgug.pa.ste/
od.ldan.lcags. [5 *a* : 1] sam.yaṅ.na.rno/
gser.ni dgug.cin.phye mar.bya//

25

tshva[6] .yi.sde.tshan.ji.sñed.daṅ/
dri.chui.sde.tshan.sbyar.'bar.bya/
tshva.dan.dri.chu.de.ñid.kyis/
blo.dañ.ldan.pas.phye mar bya//

26

kon[7] .bu.gsum.du.slans.yan.ni/
skyur.rtsi.rnam.ba.man. [5 *a* : 2] pos.gdul/
de.ni.rtsa.ba.ñid.du bya//

27

slar.yan.skyur.rtsis sbyar.bar.bya/
'di yis žans daṅ.od ldan.nam/[8]
yan.na.rnon.po 'di.yis sbyad/
glaṅ.chen.rus.phye[9] . yan.dag.sbyor/
'chin[10].bu.phye.mas.des.sbyar.bya/
lan.ni.bdun.gyi.bar.du.ni/
ra[11].yi.dri.chus.gtor. [5 *a* : 3] bar.bya//

---

6 Ms *tshve.*

7 Ms *gon bu* for *ḳon bu* (J. 5)

8 Better reading *rnams.* 9 *Phye-ma*

10. Mss. *'chid* for *'chin bu* (glass jewel J 169).

11 Mss *rva* for *ra* = *ra ma*

28

de.'dır.ǯaṅs.ni.sbyor.bar.bya/
blo.daṅ.ldaṅ.pa.rnams kyıs.bsad/
'dı.yıs ǯaṅs.nı.rab mchog.tu/
sbyaṅ.bya las.rnams.thams.cad.la//

29

de.nas.ra gaṅ.de.bǯın.du/
sbyaṅ.ba.bdag.gıs.rab.bʕad.bya/
'bad.pa.yıs nı.bdar.bar.bya/
phye [5 *a* . 4] ma.ǯib.mo.ñıd.du.bya/
tshva.bcug drı yı.chu.yıs nı/
mkhas.pas.ñı.ma.bdun du mñed[12] /
slar.yaṅ skyur.ma.daṅ.bcas.pas/
koṅ[13].bu.gsum.du.sbyın.bar.bya//

30

'dı.yı.sbyaṅ.ba.bʕad pa nı/
ra.gaṅ.cho ga jı.bǯin no/
'khar pa.'bad.pas.bdar bya.ste/
phye.ma. [5 *a* . 5] ǯıb.mo ñıd.du bya//

31

tshva.bcug.drı.yı.chu.yis.nı/
phye.ma.ñıd.nı.slar.yar.sbyaṅ/
laṅ.bdun.gyı.ni bar.du sbyaṅ/
slar yaṅ.skyur.mos.sbyaṅ.bar.bya//

---

12. Mss. *mne* for *mned* (to rub J 195).

13. Mss. *ḳod.bu* for *ḳon.bu.*

32

ža.ṅye.byin.nas.me.la.bsreg/
jı.srid.žaṅs[14].su.ma.gyur.bar/
žaṅs.kyi.gzugs.gyur.gaṅ la.ni/ [5 *a* : 6]
slar yaṅ.žaṅs sbyın sbyar.bar.bya//

33

sgra.ldaṅ sbyaṅ bar.bsad.pa yi/
gtso.bo dag.ni bdag.gı bśad/
ža.ñı sbyaṅ bar.bsad.pa.yaṅ/
jı.ltar.rigs par bdag.gis.bśad//

34

ba.blai.phye.mas.'bar.bžin du/
sır.ka ndai.'o.mas.sbyaṅ/
maṅ.par.sbyaṅ žın[15].phye.ma.dag/
ñı.ma.la.ni.spyad.par bya//

35

me.nas.žu.daṅ.phye.ma.la/
ža.ñe.yis.nı ñes par sbyar/
laṅ.bdun gyis.ni.dag.par.'gyur/
'bras bu.gsuṁ.gyis.khu bas.bkru//

36

'dı.yı.sbyaṅ.bar bśad.pa.ni/
ža ne.gśai.tshe.dag. [5 *b* : 1] bžın.bśad/
ku.na.ti [16].yi.dṅos.po.daṅ/
chaṅ gi me tog.khu.ba.yi//

---

14. Ms. reads *zens* for *zaṅs.ma* (copper) J. 486. 15. Ms[1], *zın.*
16. Ms[1] illegible, Ms[2] reads *ku na ti.*

37

de.yi.phye.ma.sbyar.bar.bya/
gsa.tshe.ras.kyis.yan.yan.du/
'od.ki.blo.gras.mar.khu.dan/
yan.na.ka.rñidra.mar.khus.snum[17]/
bkru.žin.brtor.ba.ñid.du.bya//

38

sbyar.ba.man.du.gsuns.pa.yis/ [5 b : 2]
nes.pa.man.po.rnam.par.spon/
ža.ñe.cun.zad.byin.nas.ni/
sban.ma.makhas.pas.me.la.bsreg//

39

de.bžin.gyur.pa.dri.chu.yis/
blo.dan.ldan.pas.lan.gsum.bku/
de.nas.mtha.'dan.bar.dag.tu/
lan.bdun.du.ni.bkru.bar.bya//

40

de.yis.dag.par.gyur.ba. [5 b : 3] ste/
'od.la.rnam.par.spyad.mi.bya/
gser.mi.sbyon.bar.bsad.pa.yi/
yon.tan.rnams.ni.drug.de.yi//

41

dan.po.tsha.dan.dri.chu.yis/
ji.sñed.skyur.rtsis.bkru.bar.bya/
mar.dan.sbran.dag.bsres.pa.yis/
byug.pas.slar.yan.mdzad.mi.'gyur//

---

17. Mss. (very illegible) probably *khus*. (Ms[1]). Then *snum* is to be added for metre.

42

'dı.yıs.dṅos. [5 b : 4] grub. bgrub.par.byed/
gser.gyı.rim.ba.ji.bžin.no/
lcags.rnams.gdul.par.gsuṅs.pa.yi/
jı.ltar.mı.'gyur.sbyor.ba.las//

43

gser.dnul.ji.lta.ba.de.bžin/
od.ldan.lcags dag.jı.sñed.dan/
de.yi.dnos.po.rnon.po.la/
dan.po.sbyan.bar.byas.nas.ni//

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phyı.nas.las.kyıs.mnam.du.brtsam/
mdog.bzan.mā.ksi.ka.ñid.dan/
tshva.dan.skyur.mo.dag.gi.sbyar/
gser.'gyur.tsaı.bstan.bcos.ji.sñin.pa'o// [5 b : 5]

ENGLISH TRANSLALION

In the Indian language (i. e. Sanskrit): Rasayanasastroddrti—quotations from the text of Rasayana. In the Tibetan language: *gser. 'gyur. bstan. bcos. bsdus. pa.*—quotations from the text regarding the change of base metals into gold.

Homage to the Omniscient One

1. Salutation to the Omniscient, *Iswara,* who bestows peace and good upon all beings. gives liberation from (worldly) enjoyment (*lons.spyod*)

2. Salutation to the revered *Maheswari*, who is beyond (*rnam. par grol.*—deliverance) what is gross or subtle, and is both explicit (*gsal*—visible) and non-explicit, and is one that pacifies all (*mchog. tu. zi.*). Let her bestow good and welfare (upon beings).

Mercury Products

3. After compounding with various materials many useful products can be prepared from pure and solid mercury (*dnul. chu*).

Merits of Mercury

4. Mercury has three-fold merits (*yon. tan*):

(1) Burnt mercury (*rgyal. ba*—being conquered) cures diseases. (2) Heated mercury (*smin pa*) removes poverty (of the person engaged in experiments) (3) Confined (by mystic *mantras* of the Tantric School) mercury (*bcins pa*) goes into the sky (i. e. evaporates—*mkha'. la. gro*). (There is a traditional belief that an expert can fly by holding confined mercury). [Burnt mercury obviously refers to the oxide of mercury. Ed.]

Merits of Mica

5. Heated mica (*ehan.tsher*) has eight-fold merits. Heated with sulphur (*mu.zi*), it has six-fold merits. Like

mercury, confined mica (by *mantras*) with gold facilitates flight in the sky (lit. how can you check the going into the sky)

Copper Polish

6. Take zinc on tin (*Gsa'.tse* = tin) and mercury dust (sediment) of equal proportion and powder them. Add (*zla.ba*) juice (of a kind of white coloured flower), double in proportion, with half of (the above mentioned) powder according to the method (mentioned in) spoken by Candra-paksa (*zla.bai.phyogs*). This compound can polish (*'big* —to pierce) many (lit. sixty four) sheets of copper (plates).

7. This compound without mercury (being not strewn on *mi gtor sin*) is reddish. It enriches (the compounder). The heated compound in a little viscid form is turned into sky-blue colour Then it will last long.

Method of Melting

8 The process of melting (*smin.pai.mtsan ñid*): Boil mercury properly and add silver or gold (proportionately). They will be transformed into one body and will not be decomposed any more. [This is amalgamation process—Ed].

Method of Vandha [confining]

9. The method of confining is: Add (burnt) mercury (*dban*—lit. subdued) with heated mica. It enriches (the experimenter) and leads him to the door of religion (by the Tantric practices the practitioner can attain liberation).

Gold-coloured Polish

10. These three are the rarest things on the surface of the earth:

(i) the head of the bird *cataka* (who eats sky—*kha.yan.nan mkha.zaba.dan*) (ii) the compound which is formed with sulphur and *haritala* (iii) milk of lioness

(traditional belief is that from milk of lioness pearl is formed).

11. The more these (rarest things) are old, the more they are (active). These things are to be heated and the product made by these things should be kept for many days. Then the compound will be an effective one. A large number of things (lit. one crore) will be polished. The polish being applied on iron that has glaze (*'od.ldan.-lcags*—purified iron) will be very good.

12. If those rare things be not available, the same product can be made by the following materials (1) (purified) iron (*'od.ldan.lcags*), (2) brass of 1/2 *žo* in quantity, (3) (zinc) tin, (4) copper, (5) *Rahu svarna*, a kind of flower (*sgra gcan gser)*, (6) the white (stones used for medicine), (7) iron, (8) heated mercury (*dnul chu.smin.pa*).

'Od ldan lcags. lit. means iron glaze. Here, iron is also mentioned. So it may be steel. *žo* is a kind of weight used in Tibet. 10 *žo* = 1 *sran. sran* is a kind of Tibetan coins like Indian Rupee. 1 *žo* = 1/10 oz

Other Formulae

13. For making gold (rasāyana—*gser.gyur*) these six are to be mixed (1) mercury (2) sulphur (3) (*dri med*) dirtless *nirmali* (*skt*), or *haritala* (?) in equal proportions with sulphur (4) *makshika* (a kind of stone) (5) *mtshal*, vermilion (asafoetida ?) (6) *kuntika - śikhi*.

14. The learned khows the method of preparing a compound with red ochre (*gser gyi.lelsag*) and arsenic (*ba.bla.-rnams*.J.) etc., for which they should endeavour.

Another Compound for Work on Gold

15. For making various works on gold add the following: arsenic, yellow colour (*kha.dog ser*), white metals (*dkar pos.khams*), mica and *sobhir* of equal proportions. Add *kakusatha* and melt these separately according to the method of the learned.

16. The attributes of the compound are: after distillation (*sbyans.par*) the fluid compound will be of glazy colour and of light weight. Afterwards, when it will be whitened, it will then be very acute and effective.

Classification of Copper

17. Copper is red and hard, and, is of three categories: (1) of the best quality, copper is imported from Nepal (*Bal Yul*) (2) of the medium quality, copper is as a flower leaf or petal (*'dab.ma*) (3) copper of the inferior quality has no glaze but spots.

Gold Polish on Copper

18. For the proper preparation (of gold polish) the compound (of polish) beginning with heated mercury will be made. Then the compound will be painted on pure copper (of the best quality). Afterwards this copper piece will be glazy and bright (with the polish). The compound of heated mercury is good. By this black lead will be turned into white colour. [Amalgamation—Ed.]

Polish on Lead

19. The fluid of lead is naturally light in weight. Lead with aloy will be good On black lead the polish will be soon active. The polish will make a piece of lead white.

Polish of Brass

20. The fluid of brass is like that of gold (in glaze). It removes impurity present in other metals. The fluid of brass will be more strong and firm with some alloys (being poured upon the fluid). With copper, brass will last long.

Quality of the Polish

21. The (above mentioned) compound (of polish) having no alloy (*dri.ma.yan.dag.ldan*) will give sound

(*sgra.ldan*) (a tingling sound will occur when the compound will be dropped). It is heavy, strong and very adhesive (lit. firm and superior). Being applied on copper and lead, it is thickened and will last long (lit. it will hold fast).

Qualities of Gold

22. Gold has got six qualities. It is (a) separable by cutting, (not by any other means), (b) yellow coloured when it is rubbed, (c) of saffron colour, being burnt in fire, (d) bright, (e) heavy, and (f) glittering like *kunda* flower or a shining star.

23. (Earlier) scholars enumerated sixty four *lakshana* or characteristics of gold polish, which are mentioned above and will be said later on.

Polish on Steel [glazy iron]

24. If the work be done with keen concentration the polish will act on steel (*'od.ldan.lcgas.rnams*—glazy iron, etc.) very well (lit. hold strongly). For making powder from gold or steel (glazy iron, etc.) the method will be applied.

Method of Powdering

25. The method of powdering —An expert one knows the method with a kind of salt and with a kind of urine (*dri.chu.sde.tshan*)

Method of Gold Powdering

26. Place (gold) on three earthenware pots (*kon.bu*) and add strong acid in quantity (*skyur rtsi.rnam ba.man.pos*). Then gold will be powdered.

27. In this way, copper and steel (glazy iron) will be purified by acid wash.

Another Method of Purifying Copper

28. Add elephant (*glan.-chen*) bone dust (*rus.phye*)

with glass jewel powder (*'chın.bui.phye.mas*) and sprinkle for seven times the urine of goat upon these two powders.

29. Learned men know the use of copper and its process of purification. Purified copper will be used in many ways.

Method of Purıfyıng Brass

30. The method of purifying rass is to be learnt properly. The learned knows the method of making brass dust by rubbing it with salt and urine for several days. And, afterwards, put (brass dust) ın three earthenware pots (*kon.bu*) again and again (for washing). Then brass will be purified.

Method of Purıfyıng Bell Metal

31. The method of purifying bell metal (*'khar.pa*) is similar to that of brass. (You) should learn that well. (According to the method of powdering) fine dusts from it will be made.

Then, add salt-mixed urine with those bell metal dusts and wash the material again and again for seven times.

Method of Purifyıng Lead

32. Put (some) lead into fire until it gets copper-like colour (*ji.zrid zans.su ma gyur*). When it will have copper-like colour (*zans gzugs*), add some brass again on it

33. The learned knows the method of purifying the compound (copper and burnt lead), when it will have some (tingling) sound (*sgra-ldan*). The learned purifies lead according to the *śāstras.*

34. By arsenic powder (*ba.blai.phye.mas*) which is (as strong) as burning (*'bar.bžin*), and *śrikhanda's* juice (*o.mas*) it (lead dust) will be purified by washing for a day (again and again)

35. Lead will be well purified by burning on fire, and by (arsenic compound) powder Within seven days, lead will be made pure by washing with the juice of three kinds of fruits (*bras.bu.gsum.gyis khu.bas*).

Method of Purifying Zinc

36. The process of purifying zinc is like that of lead, with the seed of *kunali* and the foamy content of wine (lit flower of wine—*can.gi me.tog.khu.da*, it may be a sort of flower from which wine is prepared).

37 The (above mentioned) powder should be pure. Add zinc to the powder and wash repeatedly by castor oil (*od gi blo.gros mar.khu*), and karanja oil (*'od ki blo gros mar khu*—literally means enkindling oil—castor oil. It may be a kind of medicine).

General Method of Purification

38. The method of purification is well described ; for, many people carry out this process wrongly. Scholars know how to burn lead in fire to make it pure by (removing alloy, or) adding malt [from which beer has been brewed (*sban. ma*)].

39. Expert people know how to extract [*bku*] by applying urine three times and by washing [seven] several times Thus the purification will be made.

Impure Gold

40 Impure gold will be detected, as [a piece of] impure gold will not shine much in light.

Causes of Impurity and Wastage of Gold

41. The six things are . [a] salt, [b] urine, [c] acid, [d] by putting oil, [e] honey, and [f] unguent (alloy, *byug.pa*). [Glod will be discoloured by these.]

Power of Siddhas

42. The learned [*siddhas—dnos grub*] can attain accomplishment of changing iron and other metals into gold, even not by applying any methods mentioned above.

Process of Making Golden Colour

43-44. Steel [glazing] iron [will shine] as gold and glitter like silver. To make the things active at first, purify the metal and then work on. Add, then *makshika*, salt and acid together to make the [polish] colour very good. *The Mulasastra of Rasāyana ends.*

[Note. On p. 124 of the main text reference has been made to this work under the name of Dhatuvadasastra or Dhatuvadasastroddrti It was stated there that in view of the imperfect impressions of the xylograph belonging to the Asiatic Society of Bengal and also of that of the Calcutta University library, it had not been possible to obtain an English translation of this work Recutly Sri Suniti Kumar Pathak of Visvabharati University, Santi-niketan, from a careful comparison of the xylographs of the Asiatic Society, Calcutta University and of the Visvabharati library has succeeded in transcribing and translating the same for us Ed]

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